## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>6</td>
</tr>
<tr>
<td>Mineral Industries Extension Services</td>
<td>8</td>
</tr>
<tr>
<td>Groups for Whom Courses Are Intended</td>
<td>12</td>
</tr>
<tr>
<td>General Information</td>
<td>13</td>
</tr>
</tbody>
</table>

### CORRESPONDENCE COURSES

#### EARTH SCIENCES

- Geography ................................................. 18
- Geology ................................................ 19
- Meteorology ............................................ 20
- Geophysics .............................................. 22
- Mineralogy .............................................. 22
- Mineral Economics ...................................... 22

#### MINERAL ENGINEERING

- Coal Mining ............................................ 22
- Natural Gas Engineering .............................. 23
- Petroleum Refining .................................... 24

#### MINERAL TECHNOLOGY

- Ceramics ................................................ 25
- Ferrous Metallurgy ..................................... 27

### EXTENSION-CLASS INSTRUCTION

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of the Work</td>
<td>30</td>
</tr>
<tr>
<td>Co-operating Agencies</td>
<td>30</td>
</tr>
<tr>
<td>How Classes May Be Organized</td>
<td>31</td>
</tr>
<tr>
<td>Teachers Selected from Industry</td>
<td>32</td>
</tr>
<tr>
<td>Curricula and Textbooks</td>
<td>32</td>
</tr>
<tr>
<td>Extension Credit</td>
<td>33</td>
</tr>
<tr>
<td>Class Schedules</td>
<td>33</td>
</tr>
</tbody>
</table>

#### EARTH SCIENCES (no extension classes)

#### MINERAL ENGINEERING

- Coal Mining ............................................ 34
- Mechanized Mining .................................... 36
- Coal Preparation ...................................... 37
- Mine Surveying ........................................ 38
- Specific Application Mining Courses ............... 39
- Natural Gas ............................................ 40
- Petroleum Refining ................................... 41
- Petroleum Production .................................. 42

#### MINERAL TECHNOLOGY

- Ceramics ................................................ 44
- Ferrous Metallurgy ..................................... 47

Textbooks and Their Costs ................................ Cover 3
THIS BULLETIN describes the courses in the field of the mineral industries that are available through correspondence instruction and extension classes.

In the pages that follow, the correspondence courses are described from the standpoint of administration and content. Many of the courses may be taken for college credit and are so designated. Several of the courses, however, because of the nature of the subject matter and the methods of and reasons for their presentation, are of less than college grade, designed to be of immediate value to men on the job, and carry, therefore, only units of industrial credit.

Industrial credits given for certain correspondence courses apply toward an industrial diploma awarded for completion of 27 units, earned either by correspondence instruction or extension class training or through a combination of both.

Inquiry from any mineral industry or any mineral industries worker in Pennsylvania, requesting information on correspondence instruction or the formation of an extension class program, will receive prompt attention. Every effort will be made to furnish all the information wanted. Mineral Industries Extension Services will be pleased to render complete assistance in organizing classes to meet the practical requirements of the individual, class, or community.

SUBJECTS AVAILABLE:

through correspondence instruction in Ceramics, Climatology, Coal Mining, Coal Preparation, Ferrous Metallurgy, Geography, Geology, Geophysical Prospecting, Mechanized Mining, Meteorology, Mineralogy, Mineral Economics, Mining Mathematics, Natural Gas Engineering, and Petroleum Refining.

EXTENSION CURRICULA:

in Ceramics, Coal Mining, Ferrous Metallurgy, Natural Gas Engineering, Petroleum Production, and Petroleum Refining.

SHORT COURSES:

in Coal Preparation, Mechanized Mining, Mine Surveying, and Mining Mathematics.

DATA:

pertaining to the administration of the work.
FOREWORD

EDWARD STEIDLE, DEAN

SCHOOL

OF

MINERAL INDUSTRIES

The School of Mineral Industries is an integral part of The Pennsylvania State College. The School is concerned with the exploration, development, and conservation of the natural mineral resources of Pennsylvania and their preparation, processing, and efficient utilization. Natural minerals are divided into three general groups: mineral fuels; metallic minerals; and nonmetallic minerals. The mineral arts and sciences embrace three distinct types of subject matter: namely, (1) the earth sciences, including geology, mineralogy, geography, geophysics, meteorology, and related subjects; (2) mineral engineering, including mineral economics, mining, mineral preparation, and petroleum and natural gas; and (3) mineral technology, including fuel technology, metallurgy, and ceramics.

Pennsylvania is the greatest mineral industrial commonwealth. Her mines and products derived from minerals account for about two-thirds of the entire productive wealth of the State. Truly, Pennsylvania’s mineral resources have been the very heart of her economic development.

In the discharge of its obligations to the Commonwealth, the School of Mineral Industries has three functions—resident instruction, extension and correspondence instruction, and research. Of these three functional divisions, the second—extension and correspondence instruction—finds expression through the Extension Services. All members of the faculty are concerned in the three functions of the School. In order that the extension program may have the advantage of the interest and concern of the entire faculty, the Extension Services was set up, not as an independent organization, but as the organized expression of an important function of the whole School.

Mineral Industries Extension Services is the College medium through which the educational resources of the School are extended and made effective throughout the State. Educational processes taken into the mines, mills, and plants result in the promotion of mutual understanding between employers and employees which is imperative for efficiency, safety, and economy of operation.

The Mineral Industries Extension service program arises from the current economic and social needs of the Commonwealth. Through this service the principles and the truths developed by study and research are translated and carried to the people and applied to the industries. The Extension Services are organized to spend their funds at the cutting edge of a program of service. The School of Mineral Industries is the only educational institution of the Commonwealth carrying on extension and correspondence instruction in the field of mineral-producing and primary processing industries. The Extension Services publish a paper, Mineral Industries, monthly, from October to May inclusive each year; the publication is devoted to the work of the entire School.

This bulletin, prepared by H. B. Northrup, Director, Mineral Industries Extension Services, describes briefly the functions of the Extension Services, including its policy and the facilities and courses of study available currently. Inquiries regarding correspondence and extension instruction in the mineral industries should be addressed to Director Northrup.

EDWARD STEIDLE, DEAN

SCHOOL OF MINERAL INDUSTRIES

H. B. NORTHRUP, DIRECTOR

Mineral Industries Extension Services
MINERAL INDUSTRIES EXTENSION SERVICES

MINERAL INDUSTRIES Extension Services began in 1893 under a special maintenance appropriation by the State Legislature for the Department of Mining Engineering of the College. The demand for mining extension came about by the enactment of mine laws and regulations in Pennsylvania requiring certification of all underground officials. This was the first organized extension training in the United States so far as the records reveal.

From 1894 to 1899, 27 extension bulletins were printed and distributed free for the benefit of the mining industry. The records show that a series of free lectures was delivered by a corps of teachers in the mining department “to the mining employees at their customary places of assembly upon matters of interest to them in their occupation.”

In 1899, Legislative action cut the College appropriation and the mining extension work had to be curtailed in proportion. Extension classes in coal mining were carried on by members of the resident faculty in the anthracite region and in central Pennsylvania from 1908–1915 in cooperation with, and assisted by, funds from the Y. M. C. A. and the Central Pennsylvania Coal Producers Association. The program again expanded in 1919 through a small College appropriation, a grant-in-aid from the Central Pennsylvania Coal Producers Association and through the utilization of Federal Smith-Hughes funds, in cooperation with the State Department of Public Instruction and the State Department of Mines. Up to this time, all of the extension instruction had been given by the resident staff in mining, but now a full-time extension man was employed to devote full attention to the program.

In 1931, the extension activities of the School were placed on an organized basis compatible with the unified program of the newly reorganized School of Mining Industries and a director was appointed to take full charge of the work. He was charged with the responsibility of carrying a program of education and training to mining industries workers throughout the State of Pennsylvania. This program parallels the work given in resident instruction by the School on the campus and consists of (1) basic, fundamental, up-grading, in-service, extension curricula of less than college grade; (2) short, specialized, advanced terminal courses; (3) college credit courses, where warranted; and (4) correspondence courses of (a) college credit, and (b) industrial credit. The formal extension class programs are limited to persons residing within the Commonwealth, but the correspondence courses are available to any person, without geographical limitations.

During the first year of the reorganized program, at a conference in Harrisburg, an agreement was consummated between the State Department of Public Instruction and the College, whereby extension classes in the field of the mineral industries could be organized by the College throughout the Commonwealth under “public supervision and control,” with the State Department of Mines and the State Department of Labor and Industry collaborating. During the conference, it was agreed that all vocational industrial classes be organized on the basis of a three-year program and that a textbook be prepared to cover each year of class instruction. Accordingly, with a mass of instruction pamphlets and lesson material as a basis, a three-year program for miners was laid out, and by 1982 three textbooks had been printed which covered a three-year program of training in coal mining.

In 1982 a program of training was initiated for workers in the petroleum and natural gas industries. Three textbooks were prepared, originally covering the entire field, but as time progressed and more experience was gained in the educational needs of the workers, the text material was expanded to cover three curricula with a three-textbook series for each, Natural Gas Engineering, Petroleum Production, and Petroleum Refining.

Similarly, three-year curricula were initiated and textbooks written for ceramics and ferrous metallurgy in 1983. Four short courses were prepared in mimeographed form in 1940 to train employees in the field of mechanized mining and the maintenance of mechanized mining equipment. These courses are short and intensive and are designed to train men for the particular type of equipment used in any individual mine. In 1942, a new, one-year course was introduced to train men in coal preparation, and in 1946, three short courses in mine surveying were approved.

The development of the service has resulted from demands on the part of industry rather than from promotion. The mineral industries extension work has to be planned from the initial contact by mineral industries supervisors who understand the language and the problems of the industry.
Regular extension courses are organized on the basis of 144 hours yearly. The student is awarded a certificate worth nine units when he has completed successfully each year of the work, and an extension diploma when he shall have completed successfully any stated three-year curriculum. The majority of the effort to date has been in industrial, up-grading training of less than college grade, but college credit training is available upon sufficient demand. The industrial training costs the student nothing except the purchase of his textbook. College credit training is usually given on a regulated fee basis.

The organization plan of Mineral Industries Extension Services is peculiar to the School. The services are integrated with the resident and research divisions of the School. A supervisor, corresponding to a department head, is responsible for the work in each field. All supervisors have had industrial experience and each is responsible for the preparation of textbooks and lesson material and in maintaining it up to date. Textbooks are printed only in sufficient quantity to last two years, according to our experience, so that each and every book is revised and brought up to date approximately every second year.

The extension supervisors also are in constant and regular contact with industry to ascertain its educational needs and to keep posted on industrial progress. They are responsible for preparing correspondence courses of less than college grade and for correcting the correspondence lessons, thus assuring the student the best instruction possible in that type of training.

The regular staff of the Services includes, in addition to the director, one supervisor and three assistant supervisors in mining extension, one supervisor each in ceramics, metallurgy, and petroleum and natural gas, and three secretaries. Over the period 1931 to 1947 the regular work of Mineral Industries Extension Services has trained 44,228 workers for Pennsylvania's mineral industries and 1200 persons through correspondence instruction.

Mineral Industries Extension Services participated in the Defense and War Training programs given by the College under the sponsorship of the U. S. Office of Education. This work was carried in addition to the regular program. During the period 1940–44, college level training was given under this program to 7138 persons.

The grand total of persons trained by Mineral Industries Extension Services, therefore, for the period 1931–47 is: (a) regular extension and correspondence training 45,428, (b) defense and war training 7138, for a grand total of 52,566, or an average over the 16 year period of 3285 persons annually. The training has been given in 287 class centers, in 50 of the 67 counties of the Commonwealth.

Mineral Industries Extension Services training is available to any persons or group of persons in the Commonwealth, and the College is prepared to render its extension service to meet any new demands made upon it in training workers to take their proper places under the new order.
MINERAL INDUSTRIES
CORRESPONDENCE COURSES

Correspondence instruction is an important part of the extension service of the School. The college credit courses are available to any interested person who has acquired the prerequisites necessary for enrollment in any given course; the general interest courses, requiring no college prerequisites, are available to anyone and cover the same ground as similar courses in extension classes. The quality, as well as amount of work required for college credit courses, corresponds to that prescribed for similar courses given on the campus. This service is available anywhere at any time up to the limit of the facilities of the division. All courses offered by the Extension Services are prepared and conducted by members of the School faculty. This arrangement insures conformity with College standards in the administration of the work.

GROUPS FOR WHOM COURSES ARE INTENDED

The correspondence courses described in this bulletin will be of particular interest to the following groups:

(1) High school graduates who are unable to continue their education immediately. Through correspondence study they can earn advanced credits while they are working to obtain means for financing the cost of a college education. Thus they are enabled to retain the attitude of students until the opportunity of doing resident work in college is presented.

(2) Regular college students compelled temporarily to discontinue resident study, or desirous of completing courses during the vacation period. Through correspondence instruction they are enabled to continue their studies.

(3) Persons who want to keep abreast of the times and prepare for advancement in their special fields of interest. They can do through the aid of the Correspondence Study Division.

(4) Personnel of the Armed Forces of the United States, all of whom may enroll in any of the courses that may meet their needs under the terms of the contract between the College and the United States Armed Forces Institute.

(5) Discharged personnel of the Armed Forces of the United States who may elect to take advantage of the opportunities for self-improvement by studying subjects offered through correspondence instruction under Public Law 346 (the G. I. Bill of Rights) or Public Law 16, as administered by the Veterans Administration.

GENERAL INFORMATION

A student may enroll at any time during the year.

A correspondence course may be completed without interruption, as rapidly or as slowly as desired, at home or elsewhere in spare hours, unhampered by classroom limitations, but subject to the time limit placed on course completion.

Recitation takes written form, helping the student to think logically, training him in the arrangement of data, and developing his ability to express himself.

Correspondence courses develop to a marked degree the student's initiative, self-reliance, accuracy, and perseverance.

Correspondence students fall into two general classifications:

The EXTENSION STUDENT—a student who studies correspondence subjects for self-improvement, training, and advancement.

The NONRESIDENT STUDENT—a student who studies correspondence subjects for college credit.

NONRESIDENT STUDENTS

A student who wishes to study college credit correspondence subjects before he begins his resident work must be registered as a nonresident student by the College Examiner. Therefore, he should communicate with the College Examiner before enrolling for a correspondence subject.

All questions concerning credit for subjects studied elsewhere must also be answered by the College Examiner.

If a student wishes to use the College correspondence credit at another institution, he should secure approval from that institution before enrolling for any subject with the College.

A resident student (one who is already enrolled for a course on the campus) must have the written approval of his dean before enrolling for a subject to secure credit toward his degree.

The Registrar of the College is officially notified when a student successfully completes a college credit subject.
A grade report is issued from the Registrar's office to each student upon the successful completion of a college credit correspondence course. Official transcripts of a student's Correspondence Study record will be mailed by the Registrar of the College upon payment of the usual fee of $1.00.

CREDITS

Courses carrying "units" are not equivalent to any courses taught in residence. The principal purpose of these courses is to give instruction in the more essential principles without adhering to curricular college credit requirements. Accordingly, such courses do not carry credits applicable toward a degree.

Courses carrying college credits cover the same ground as similar courses taught in residence and are equivalent to one hour of recitation per week for one semester for each credit.

(Please Note: not more than 15 credits toward a degree at The Pennsylvania State College may be earned through correspondence study.)

Credit earned by correspondence may not be presented for graduate credit.

FEES

The fee for each correspondence subject is listed with the course description. This fee covers lesson instructions, postage paid by the College in returning lesson reports, and the service of the instructor. An extra postage fee of $1.00 per subject will be made for students outside of the United States.

TEXTBOOKS

Additional cost for texts or other material is also given with the course description. All required text material may be obtained through Mineral Industries Extension Services.

The titles, authors, and publishers of required textbooks, as given, are not necessarily accurate. Books may be changed between the time of printing the bulletin and the time when the student enrolls.

TRANSFERS

A request to transfer to another subject must be made before the initial time limit for completion has expired. If the College is responsible for the transfer and no lessons have been submitted, there will be no transfer fee. If the student is responsible, a fee of $1.00, plus the cost of additional lesson service and supplies, will be made.

REFUNDS

Upon a student's written notice to the College that he has permanently discontinued study in a course for which the initial time limit has not expired, a refund shall be made amounting to 50 cents for each lesson paid for but not submitted, provided that not more than one-half the lessons have been submitted. The balance of the fee shall be retained by the College to cover administrative expense. There will be no refund to any student who has submitted at least one-half the lessons.

TIME LIMIT

A student is allowed one year in which to complete each course of three or less college credits, or the equivalent in industrial credits. When the time limit for completion has expired, the student is notified that his records have been transferred to the inactive files. He will, therefore, be required to pay a fee of $1.00 to be reinstated for a period of six months.

If the College is responsible for delays or the student has some exceptional reason, such as illness, for not completing the course within the time limit, the time will be extended an appropriate number of months without assessment of an additional fee. If a student's time limit has expired and the text or lesson material in his course has been superseded, he shall not be eligible for reinstatement.

HOW TO SUBMIT LESSONS

All lessons, except drawings or those specifying a particular kind of paper, are to be submitted on the lesson report paper provided by the College. The student should fill in the heading of the First Sheet very carefully, using ink or typewriter, since it is used both for identification in the office and for return mailing in a window envelope.

Lessons should be mailed in one of the envelopes furnished. Should the student require more lesson report paper and envelopes, an additional supply will be sent for 25 cents.

FINAL EXAMINATIONS

When a student enrolls for a college credit subject, he is sent a special registration card. This card must be filled in and returned promptly for maintenance of records in the office of the Registrar. If the card is not returned, no final examination is given.

Final examinations are given and the grades are determined by the head of the resident department who has jurisdiction over the subject matter.
The Extension Services handle the administrative procedure of approving the proctor whom the student has secured. This proctor must be:

A member of the administrative or academic staff of The Pennsylvania State College, or
An official of the public schools whose name appears in the Pennsylvania Education Directory, or
A college official, whose name appears in an educational bulletin, which the student must have sent to Mineral Industries Extension Services.

Proctors will be suggested, upon request.

GRADING SYSTEM

The grading system used by the Extension Services is as follows:

3 = 90–100 inclusive—excellent
2 = 80–89 inclusive—good
1 = 70–79 inclusive—fair
0 = 60–69 inclusive—passing
−1 = 45–59 inclusive—failure
−2 = below 45—failure

CERTIFICATES AND DIPLOMAS

The Mineral Industries Extension Certificate is awarded upon successful completion of a subject course.

The Mineral Industries Extension Diploma is awarded upon the successful completion of a series of related subjects offered as a curriculum amounting to 27 units earned by study through the Extension Services.

MONTHLY PROGRESS REPORT SERVICE

A monthly report of a student's progress will be sent to his employer upon request.

LIBRARY EXTENSION SERVICE

Students of The Pennsylvania State College Extension or Correspondence Courses, residing within Pennsylvania, who are without any other public library service, may borrow directly from the State Library at Harrisburg. Eligible students desiring to avail themselves of this service at any time should communicate with the Extension Librarian, Library Extension Division, State Library, Harrisburg, Pa.
CORRESPONDENCE COURSES IN MINERAL INDUSTRIES

EARTH SCIENCES

GEOGRAPHY


GEOG. 26C. ECONOMIC GEOGRAPHY: The geography of the world’s commodities and their regional aspects. Land uses, extractive and manufacturing industries are studied as to their natural and cultural relationships. Textbook: Jones, C. F., and Darkenwald, G. G., Economic Geography, The MacMillan Company, 1941, $4.70. 24 assignments. Fee $27; 3 college credits.

GEOG. 30C. GEOGRAPHY OF NORTH AMERICA: A survey of America north of the Rio Grande: a description and interpretation of the industries, the farms, forests, towns, and highways that have developed as a result of the human occupation and use of each of the regions with its characteristic conditions of climate, topography, soil drainage, and natural resources. Textbook: Smith, J. Russell, and Phillips, M. Ogden, North America, Harcourt, Brace and Co., Inc., 1940, $4.75. Set of 12 maps, No. DD5, A. J. Nystrom Co., Chicago, Ill., $0.36. 24 assignments. Fee $27; 3 college credits.

GEOG. 32C. GEOGRAPHY OF PENNSYLVANIA: A survey of the geography of the State. The climate, topography, soils, mineral resources, and other elements of Pennsylvania’s natural environment, followed by a brief summary of the historical geography. The State will be discussed by geographic regions, the various outstanding industries being taken up in connection with the regions in which they are most important. Textbook: Murphy, Raymond E., and Murphy, Marion, Pennsylvania: A Regional Geography, The Pennsylvania Book Service, $4.00. Set of 20, letter size, outline maps of Pennsylvania, Rand McNally Co., $0.25. 24 assignments. Fee $27; 3 college credits.

GEOG. 42C. GEOGRAPHY OF EUROPE: The geographic factors in the economic, social, and political progress of the nations; emphasis on the major natural regions, distribution of resources, industrial development, and major problems of the continent in light of the geographic background. Prerequisites: Geog. 24C, Com. 60. Textbook: Hubbard, G. C., The Geography of Europe, D. Appleton-Century Co., 1937, $5.00. 24 assignments. Fee $27; 3 college credits.

GEOLOGY


*Students who have taken Geog. 34C should elect this course rather than Geol. 31C.
**Do not include cost of maps in making prepayment for course upon registration. Student should purchase maps directly from Professor C. W. Robinson, Division of Geology of this School.
Set of outline maps, $0.50; set of geologic maps and folios, $4.00. 24 assignments.

27; 3 college credits.

GEOL. 451C. ECONOMIC GEOLOGY: The more important metallic and nonmetallic mineral deposits, gold, silver, lead, zinc, iron, coal, oil, clays, etc. Mineralogy, geological relationships, geographical distribution and economic considerations are emphasized. Prerequisites: Geol. 31C, 32C, and Min. 31C. Textbook: Bateman, A. M., *Economic Mineral Deposits*, John Wiley and Sons, Inc., $5.00. Set of outline maps, $0.50. 24 assignments.

Fee $27; 3 college credits.


Fee $27; 3 college credits.

METEOROLOGY

METEOR. 300C. WEATHER AND MAN: A nontechnical treatment of the fundamentals of meteorology, such as weather elements, air masses, fronts, cyclones and anticyclones, etc., and evaluation of weather and climate as related to agriculture, architecture, aviation, public utilities and transportation, business and industry, health and recreation. Textbook: Neuberger, H., *Weather and Man*, Prentice-Hall, Inc., 1947, $8.50. 16 assignments.

Fee $18; 2 college credits.

METEOR. 310C. GENERAL METEOROLOGY: The principles of modern synoptic meteorology, including such topics as fronts and air mass analysis; observation of weather elements and mapping for the three dimensions of the atmosphere; weather forecasting. Prerequisites: one year of general college physics and mathematics, including differential calculus. Textbook: Byers, Horace R., *General Meteorology*, McGraw-Hill Book Co., Inc., 1944, $5.50. 24 assignments.

Fee $27; 3 college credits.


Fee $27; 3 college credits.


Fee $27; 3 college credits.


Fee $9; 3 units.

METEOR. 901C. PRACTICAL EXERCISES IN ELEMENTARY METEOROLOGY: The fundamentals of meteorology are covered, including work on weather elements, codes, charts, circulation, highs and lows, air masses, fronts, stability, thunderstorms, forecasting from local signs, etc. Prerequisite or concurrent: Meteor. 900C. Textbook: *Workbook in Elementary Meteorology*, Caudle, F. L., McGraw-Hill Book Co., Inc., 1945, $1.25. 8 assignments.

Fee $9; 3 units.

METEOR. 902C. WEATHER OBSERVATIONS AND INSTRUMENTS: Contains the general principles of weather observations and the standard instruments employed. Outlines are given of projects for observing weather elements and phenomena, and for the construction of some home-made measuring devices. Elementary statistical methods for compilation and utilization of observational data are discussed. Prerequisite or concurrent: Meteor. 900C.

GEOPHYSICS

GEOPHYS. 304C. GEOPHYSICAL PROSPECTING FOR OIL: The theory, practice, and interpretation of seismic, gravitational, magnetic, electrical, geothermal and radio-active measurements, made over the ground or in bore holes, in the search for commercial accumulations of oil and gas. Prerequisite: Geol. 31C; Phys. 285. Textbook: Nettleton, L. L., Geophysical Prospecting for Oil, McGraw-Hill Book Co., Inc., $6.00. 24 assignments. Fee $27; 5 college credits.

MINERALOGY

MIN. 53C. ELEMENTARY MINERALOGY: For students in the Schools of Agriculture and Chemistry and Physics. Prerequisite: Chem. 1 or 3. Textbook: Dana, E. S., Minerals and How to Study Them, John Wiley and Sons, Inc., $2.00. Tray of minerals: Ward's Natural Science Establishment, $8.75. 16 assignments. Fee $18; 2 college credits.

MINERAL ECONOMICS

MIN. EC. 1G. MINERAL ECONOMICS AND TECHNOLOGY: The development of the mineral industries, their relationship to the industrial era, and their role in peace and war; a summarization of the geologic genesis of ores and fuels, their world-wide distribution and the economics of the industries based on their exploitation. Detailed instruction is emphasized with regard to the production and utilization of the mineral fuels, iron and steel, and ferro-alloy elements and the common nonferrous metals. Textbook: Lowering, T. S., Minerals in World Affairs. Prentice-Hall, Inc., 1943, $4.00. 24 assignments. Fee $27; 3 college credits.

MINERAL ENGINEERING

COAL MINING

MNG. 901C. ELEMENTARY COAL MINING: Designed to provide the knowledge necessary to obtain and hold supervisory and other advanced types of jobs around coal mines. It includes basic studies in English, geology, arithmetic, mining physics, mining chemistry, mine gases, detection of gases, and elementary mine ventilation. The mining laws of Pennsylvania are studied as related material; prepares for the fire boss certificate examination. Textbooks: Jones, D. C., Coal Mining, Volume I, Mineral Industries Extension Services, $3.00. Mining Laws of Pennsylvania. 24 assignments. Fee $27; 9 units.

MNG. 902C. INTERMEDIATE COAL MINING: Includes basic studies in mine lighting, advanced mine ventilation, algebra, combustion and oxidation, mine fires, mine explosions, rock dusting, mine safety and accident prevention work, mine surveying and mapping, explosives and blasting, and mine electricity; prepares for the mine foreman certificate examination. Prerequisite: Mng. 901C. Textbook: Jones, D. C., Coal Mining, Volume II, Mineral Industries Extension Services, $3.00. 24 assignments. Fee $27; 9 units.

MNG. 903C. ADVANCED COAL MINING: Includes basic studies in trigonometry, ventilation practices, mining methods, mine timbering methods, steam, compressed air, mine drainage, mine haulage, and preparation of coal. Although not considered as an examination-preparation course, it provides information of value to persons who expect to qualify for mining certificates of rank higher than foreman. Prerequisite: Mng. 902C. Textbook: Jones, D. C., Coal Mining, Volume III, Mineral Industries Extension Services, $3.50. 24 assignments. Fee $27; 9 units.

MNG. 905C. MECHANIZED MINING ELECTRICAL APPLICATIONS: Intended for mine maintenance men but can be utilized as an upgrading program by other types of mine workers; provides the basic principles of proper and "permissible" operation of mechanized mining electrical equipment and proper maintenance procedure. Related mathematics and that portion of the mining laws of Pennsylvania governing the operation of electrical equipment in gassy coal mines are studied as related material. Textbooks: Jones, D. C., Mechanized Mining Electrical Applications, and, Mining Mathematics, Mineral Industries Extension Services, $5.00. Mining Laws of Pennsylvania. 24 assignments. Fee $27; 9 units.

NATURAL GAS ENGINEERING

PET. E. 901C. NATURAL GAS ENGINEERING FUNDAMENTALS: The fundamentals of mathematics, physics, and inorganic chemistry, the history and development of the industry, and the properties and testing of petroleum products. No prerequisites, but graduation from a four-year high school

**PET. E. 902C. EXPLORATION AND DRILLING:** Exploration, drilling, and development of petroleum and natural gas reservoirs, petroleum geology, geochemical and geophysical prospecting, rotary and cable-tool drilling, well testing and completion, reservoir behavior and secondary recovery, fundamental geology, petroleum mineralogy, leases and leasing, and chemical and physical properties of petroleum and natural gas. Prerequisite: Pet. E. 901C. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Production, Volume II, Mineral Industries Extension Services, $4.00. 24 assignments. Fee $27; 9 units.

**PET. E. 903C. NATURAL GAS ENGINEERING:** Practical engineering training in gas handling practices for men employed in the natural gas industry. The course is divided into three sections: (1) the early history and economics of the industry, completion and operation of gas wells, elimination of gas hydrates, maintenance of gas wells, measuring the capacity and estimating the value of gas properties; (2) gathering systems, flow formulas, pipe line construction, compression and natural gasoline plant operation; (3) the measurement of the properties of natural gas, types and use of displacement and orifice meters and field and distribution regulation of gas pressure. Prerequisite: Pet. E. 902C. Textbook: Stephens, M. M., Natural Gas Engineering, Volume III, Mineral Industries Extension Services, $4.00. 24 assignments. Fee $27; 9 units.

**PETROLEUM REFINING**

**PET. E. 904C. PETROLEUM REFINING ENGINEERING FUNDAMENTALS:** Petroleum refining engineering with problems specifically applied to this field including development of the industry, products of the petroleum industry, mathematics, physics, inorganic chemistry and introduction to petroleum and natural gas production. No prerequisites, but graduation from a four-year high school is desirable. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Engineering, Volume I, Mineral Industries Extension Services, $3.50. 24 assignments. Fee $27; 9 units.

**PET. E. 905C. UNIT PROCESSING:** Unit processes used in refining crude petroleum including methods and equipment used in distillation, cracking, polymerization, alkylation, dewaxing, filtration, grease compounding, chemical and solvent treatment of petroleum products, organic chemistry, control laboratory practices, storage of products and water conditioning. Prerequisite: Pet. E. 904C. Textbook: Stephens, M. M., Petroleum Refining, Volume II, Mineral Industries Extension Services, $3.50. 24 assignments. Fee $27; 9 units.

**PET. E. 906C. PETROLEUM REFINING ENGINEERING:** Practical engineering and applied basic laws of unit processing, including the design and operation of units and equipment. The course is divided into two sections: (1) fluid flow, pumps, valves, heat transfer, heat exchangers, and an advanced study of distillation; (2) the fundamentals of design of stills and pipe heaters, distillation units, cracking units and the operation procedures of the units. Instrumentation, automatic control, refrigeration, and refinery corrosion are included. Prerequisite: Pet. E. 905C. Textbook: Stephens, M. M., Petroleum Refining, Volume III, Mineral Industries Extension Services, $3.50. 24 assignments. Fee $27; 9 units.

**MINERAL TECHNOLOGY**

**CERAMICS**

The requirement for an Extension Diploma in Ceramics is the satisfactory completion of four courses related to any one of the following major classifications: (1) Glass; (2) Enamels; (3) Refractories; (4) Whitewares; and (5) Heavy Clay Products.

Some of the courses are common to more than one classification, and the student should select his courses and their sequence in a manner that will best fulfill his aims.

**CER. 911C. CERAMIC RAW MATERIALS:** The occurrence, properties, uses, and preparation of ceramic raw materials including silica, alumina,feldspars, lime, magnesia, dolomite, the fluorine minerals, the alkali minerals, the boron minerals, all with special emphasis on clays; the industrial operations of crushing, grinding, screening, and mixing; the mineralogy, geology, chemistry, and physics of the materials. Textbook: McNamara, E. P., Ceramics, Volume II, Mineral Industries Extension Services, $3.00. 18 assignments. Fee $20.25; 7 units.

**CER. 912C. FORMING AND GLAZING HEAVY CLAY PRODUCTS:** The manufacture and properties of heavy clay products with special reference to the soft mud, stiff mud, dry press, and slip casting methods of forming, in
cluding many of the standard specifications for heavy clay products, and
the manufacture and application of clear and colored glazes. Textbook:
McNamara, E. P., Ceramics, Volume III, Mineral Industries Extension
Services, $3.50. 18 assignments.
Fee $20.25; 7 units.

CER. 913C. DRYING AND FIRING CLAY PRODUCTS: Fundamentals of drying,
driers, the theory of firing, periodic kilns, tunnel kilns, setting, pyrometry,
fuels and their combustion, refractories for kilns and furnaces. Textbooks:
McNamara, E. P., Ceramics, Volume II, and McNamara, E. P., Ceramics,
Volume III, Mineral Industries Extension Services, Volume II, $3.00; Volume
III, $3.50. 18 assignments.
Fee $20.25; 7 units.

CER. 914C. CERAMICS CALCULATIONS AND TESTING OF CLAYS AND CLAY
PRODUCTS: Calculations involved in working with body and glaze batches
and computing the various physical properties of raw clays, fired clay
products, and whitewares. Included are the various physical and chemi-
tical tests commonly made on raw clays and fired bodies as well as the
apparatus involved in the various tests. Textbook: McNamara, E. P.,
Ceramics, Volume III, Mineral Industries Extension Services, $3.50. 18
assignments.
Fee $20.25; 7 units.

CER. 915C. FORMING REFRACTORY PRODUCTS: Common and special meth-
ods of forming both clay and nonclay refractories, including hand mold-
ing, stiff mud, dry press, and slip casting. Textbook: McNamara, E. P.,
Ceramics, Volume III, Mineral Industries Extension Services, $3.50, Mime-
ographed Notes, $1.50. 18 assignments.
Fee $20.25; 7 units.

CER. 916C. REFRACTORIES AND THEIR TESTING: Standard methods of test-
ifying refractory raw materials and finished products including the calcula-
tions and apparatus involved; the uses of, and specifications for the various
types of refractories. Textbook: Manual of A.S.T.M. Standards on Re-
fractory Materials, $1.50. 18 assignments.
Fee $20.25; 7 units.

CER. 917C. FORMING AND GLAZING WHIT EWARES: The properties, manu-
facture, and glazing of whiteware products including vitreous and semi-
vitreous products, and a detailed study of the various methods of forming
clay wares such as throwing, hand molding, jiggering, dry pressing, and
slip casting. Textbook: McNamara, E. P., Ceramics, Volume III, Mineral
Industries Extension Services, $3.50. 18 assignments.
Fee $20.25; 7 units.

CER. 918C. GLASS: Glass manufacture, including glass raw materials and
their preparation, batch preparation and calculations, combustion and
fuels, furnaces, melting and glass working processes, strain and annealing,
color and decoration, physical properties of glass, testing, defects, and
refractories for glass furnaces. Textbook: Scholes, S. R., Modern Glass
Practice, Industrial Publications, $6.00. 24 assignments.
Fee $27; 9 units.

CER. 919C. ENAMELS: The preparation of enamels and their application to
to metal surfaces, including enamel raw materials, physical properties of
enamels, opacity and color, the metallurgy of enameling iron and steel,
the preparation of metal surfaces, enamel calculations, compositions of
enamels, frit making, milling, application of frit to metals, firing (burning);
properties and testing of enamels and enameled ware. Textbook: Andrews,
A. I., Enamels, Twin City Publishing Company, $5.50. 24 assignments.
Fee $27; 9 units.

FERROUS METALLURGY

MET. 900C. PROCESS FERROUS METALLURGY: Steel making processes and
the fabrication of steel into the common semi-finished and finished products;
information on current plant practices of value to men employed in the steel
industry and to others who wish a general survey of steel mill operations;
a brief survey of certain fundamentals of inorganic chemistry and physics.
Includes discussion of: pyrometry, metallurgical fuels and their combustion,
fluxes, slags and refractories, theory and operation of the iron blast furna-
ces, principles of iron founding, production of wrought iron, Bessemer,
open hearth, electric furnace, and special processes of steel making, the
steel ingot, rolling mill practice, the manufacture of steel strip, sheet, tin
plate, wire, tubular products, and structural shapes, general welding meth-
ods, forging practice, the steel foundry. Textbook: Teichert, E. J., Ferrous
24 assignments.
Fee $27; 9 units.

MET. 905C. PHYSICAL FERROUS METALLURGY: The metallography and
heat treatment of iron and steel, embodying modern theory and current
practices of heat treatment; designed for men employed in heat treating
plants or who are responsible for the purchasing, testing, and specification
of steel; includes laboratory technique, nondestructive testing, physical
testing, constitution of alloys, the iron-carbon diagram, the metallography
of steel castings and cast iron, the mechanical treatment of steels, theory
of hardening, grain size, case hardening, general effects of alloying elements,
alloy steels such as stainless and tool steels, cast irons and their treatment.
Prerequisite: Met. 900C or graduation from a four-year high school course

**MET. 920C. PRACTICAL METALLURGY FOR THE STEEL FOUNDRY.** Upon request.

**MET. 921C. PRACTICAL METALLURGY FOR THE GRAY IRON FOUNDRY.**
(Note: Not offered this year.)
MINERAL INDUSTRIES
EXTENSION-CLASS INSTRUCTION

SCOPE OF THE WORK

Mineral industries extension-class instruction is a form of adult education. The majority of the work consists of programs of education and training of less than college grade, the specific purpose being to equip workers for the effective pursuit of occupations and to prepare them to understand and appreciate constantly changing industrial practices. Extension classes may be organized in any mineral industries area or section of the Commonwealth to train adults employed by the industries of that area. Such training enables those who have begun employment, without finishing their schooling, to receive further training which will fit them to do better work, and prepare for promotion. It is necessary, in order that this type of education may be effective, to have the fullest co-operation of the employer, as well as the appreciation and financial support of the State Legislature. College credit class subjects in the mineral industries field are available also, on a fee basis, upon sufficient demand.

CO-OPERATING AGENCIES

In August, 1931, the College entered into an agreement with the State Departments of Public Instruction, of Mines, and of Labor and Industry, covering a broad program of co-operation. It was agreed that The Pennsylvania State College, as the recognized leader in mineral industries education of the State, should be responsible for extension lesson material and should supervise the conduct of the extension classes. Under the plan the College was assured the co-operation of the State Department of Public Instruction, which administers the federal and State funds under the federal and State vocational acts, in forming evening mineral industries extension classes under the immediate jurisdiction of the local public school systems.

Under these acts, the Federal Government allocates certain funds to each state to be used for vocational education. These funds must be matched by state funds directed to the same purpose. Money for paying the teacher is supplied by the local school district. After the classes close for the term, the local school district makes affidavit of the money expended for instructional purposes to the State Department of Public Instruction and furnishes other data pertaining to the classes. After audit, the State Department of Public Instruction, as custodian of federal and State funds, reimburses the local school district for the amount of money expended by them in conducting the work. Vocational Acts funds have been used by the School in connection with mining extension classes since 1919.

Under the federal and State vocational acts, the vocational student is afforded an education at a minimum cost. His only expense is the purchase of text material, prepared by the College and approved by the State Department of Public Instruction. This text material will be of value to him throughout his vocational employment.

HOW CLASSES MAY BE ORGANIZED

Extension classes may be organized in Pennsylvania under the federal and State vocational acts by any group of 20 or more men who make a written application to their local school board for the establishment of a vocational class. The members of this group shall be more than 16 years of age, residents of the same school district, and not in attendance at any public or private school during the day. Mineral Industries Extension Services and the State Department of Public Instruction collaborate in the establishment of the class and in meeting all the requirements of the law with relation to the federal and State provisions under the vocational acts and in the proper certification of the teacher of such a class, pursuant to the Pennsylvania school code.

Mineral Industries Extension Services will assist any group of mineral industries employees in Pennsylvania desiring educational training, or any mineral industry, technical society, or other agency wishing to form a class independent of the State Department of Public Instruction and the local school system. Such classes may be formed within and under the immediate control of the industry. These so-called "captive" classes are able to confine their efforts to the more intimate problems of the particular industry. Such classes usually can be formed at the request of 20 or more men under a financial arrangement among the company, the class, and the College, upon a strictly nonprofit basis. This plan promotes the most effective method of employee training. The Pennsylvania State College either supplies all lesson material for such evening extension classes so formed, or assists in the preparation of such lesson material as may be applicable to the local industry.
TEACHERS SELECTED FROM INDUSTRY

To teach an evening vocational class in mineral industries under "public supervision and control," the teacher shall have had at least six years of trade or industrial experience, or its equivalent, and training approved by the Department of Public Instruction. In addition, he should be recommended by his employer, and he should also have sufficient prestige to command the respect of the men in industry. Having these qualifications, he is provided with a vocational extension teacher's certificate and should then be elected by the local school board, thereby becoming an integral part of the local school system and, as such, should be regularly reimbursed as are other teachers under the same system. The amount of the teacher's reimbursement should be decided upon by the local school board, subject to the approval of the State Department of Public Instruction, after consultation with a representative of Mineral Industries Extension Services. Teachers of captive classes are selected from industry by arrangement and are not required to have vocational teachers' certificates and need not comply with any of the school laws of the Commonwealth.

CURRICULA AND TEXTBOOKS

Mineral Industries Extension Services was organized in 1931 and sufficient time has not been available to prepare either correspondence courses or extension lesson material for all mineral industries subjects which are amenable to correspondence instruction or extension classes. The courses available through correspondence have been listed in this bulletin. The subjects available through extension-class instruction include: ceramics, coal mining, coal preparation, ferrous metallurgy, mechanized mining, mine surveying, natural gas engineering, petroleum production, petroleum refining, and shot firer's and machine runner's courses.

All the extension curricula, excepting coal preparation, mechanized mining, mine surveying, and shot firer's and machine runner's courses are standardized on a three-year basis. Text material has been prepared for each course of a given curriculum by the supervisor of the Mineral Industries extension staff who is responsible for that work. Members of the extension staff are assisted in this preparation by the resident teaching staff of the School in a particular subject. Textbooks are published in a standardized 6 by 9-inch bound volume for most of the subjects; the course in coal preparation utilizes manufacturer's information data. The texts are kept up to date by frequent revision and improvement and an adequate supply is available at all times. All extension textbooks may be purchased from Mineral Industries Extension Services by an individual or company at any time through U. S. postal money order or company check included with the order. The sale prices of the texts are listed on the last page of this bulletin.

EXTENSION CREDIT

All mineral industries extension students desiring credit from Mineral Industries Extension Services will be required to use the standardized text material of the Extension Services. Credit is given as follows: completion of each year's work with satisfactory coverage of the text material indicated for that year entitles the student to nine units of credit toward an industrial diploma; upon the completion of the course, which is customarily done in three years of class attendance (with the exception of coal preparation and mechanized mining), the student will receive an extension diploma in the practical subject which he has studied. Students completing courses shorter than three years of work will receive certification cards carrying "units" on the basis of 16 hours of recitation for each unit. The diploma is an industrial diploma and carries no college credit, but it is an indication to any employer that the man holding it has completed satisfactorily a prescribed course of study in the occupation in which he is engaged.

CLASS SCHEDULES

Mineral industries extension classes are organized usually on the basis of a minimum of 150 class hours per year. This requirement is met usually by organizing classes to meet under any one of the following plans:

- 37 1/2 weeks, 2 nights per week, 2 hours per night, or
- 30 weeks, 2 nights per week, 2.5 hours per night, or
- 25 weeks, 3 nights per week, 2 hours per night.

When a student registers for any mineral industries extension class organized under the vocational acts, he will execute the regular class registration card and make a deposit. The price of the textbook will be deducted from the deposit. The balance will be rebated if he attends class on 75 per cent of the scheduled meeting nights.
MINERAL ENGINEERING

COAL MINING

The series of courses in coal mining offered to students in extension classes has been designed not only to meet the individual needs of the mine workers but also to benefit the anthracite and bituminous coal mining industries of Pennsylvania. One of the more important purposes of the series is the upgrading of those individuals who attend classes, and this is done by providing courses in practical coal mining that cover virtually every phase of operations in both industries, yet are written to be within the range of understanding of the average mine worker. Again, there is a continuing need for certified men to replace those who retire, or to fill new positions created through expansion of mining activities or through new requirements of the mining laws of the State, and students who attend our extension classes are uniformly successful in securing the particular type of certificate they desire because they have been drilled in the required fundamentals by competent instructors. Once having secured the supervisory job for which he is certified, the individual finds that the knowledge gained in class is of considerable assistance in the proper performance of his daily duties. Regardless of the particular purpose that prompts an individual to attend a coal mining extension class, the completion of a single course, and preferably of all three courses, will make him more valuable to his employer and the particular industry in which he is engaged.

The courses are generally applicable to both anthracite and bituminous coal mining practices, but where some portion of a course touches on a phase of mining peculiar to either industry, that phase is treated separately for the benefit of the students in that particular industry. The classwork is articulated, or the studies in the initial course are preparatory for the later studies in the second course, and these studies in turn are preparatory for the third course studies. The following descriptions will give the general purpose and coverage of each year of work:

MNG. 90IX. ELEMENTARY COAL MINING: A practical coal mining course designed to provide the knowledge necessary to obtain and hold supervisory and other advanced types of jobs around coal mines. It includes basic studies in English, geology, arithmetic, mining physics, mining chemistry, mine gases, detection of gases, and elementary mine ventilation. The mining laws of Pennsylvania are studied as related material. This course

MNG. 902X. INTERMEDIATE COAL MINING: This course includes basic studies in mine lighting, advanced mine ventilation, algebra, combustion and oxidation, mine fires, mine explosions, rock dusting, mine safety and accident prevention work, mine surveying and mapping, explosives and blasting, and mine electricity. This course prepares for the mine foreman certificate examination. Prerequisite: Mng. 901X. Textbook: Jones, D. C., Coal Mining, Volume II, Mineral Industries Extension Services, $3.00, 9 units.

MNG. 903X. ADVANCED COAL MINING: This course includes basic studies in trigonometry, ventilation practices, mining methods, mine timbering methods, steam, compressed air, mine drainage, mine haulage, and preparation of coal. Although not considered as an examination-preparation course, it provides information of value to those persons who expect to qualify for mining certificates of rank higher than foreman. Prerequisite: Mng. 902X. Textbook: Jones, D. C., Coal Mining, Volume III, Mineral Industries Extension Services, $3.50, 9 units.

MECHANIZED MINING

Mechanized mining courses are intended to upgrade persons who are employed in the operation, supervision, or maintenance of mechanized mining equipment. Any training program consisting of one or more of these courses is essentially "educational" and should not be confused with apprentice work. The courses have been designed to supplement the daily work of mine employees, rather than to prepare them for specific jobs in or around coal mines.

The development of mechanized mining courses resulted from the request of coal companies for training programs that would assist mine employees to have a better understanding of operating and maintenance problems incidental to the introduction of mechanized mining methods into their respective mines. The initial training classes were of the captive type, and the costs of operation were borne by the sponsoring company. This type of program is still available to any company that wishes to restrict the training work to company employees, and information on the methods of operation and costs can be secured by contacting Mineral Industries Extension Services. One course, Mng. 905X, is now being operated in a number of locations under public school supervision and control, and this provides opportunities for men from any mining company in the vicinity of such training centers to take advantage of this educational course. It is possible that all of the mechanized mining courses will eventually be offered in similar schools, centrally located for mining areas. The coverage and general purpose of each course is as follows:

MNG. 904X. MECHANIZED MINING MECHANICAL MAINTENANCE: Machines that are used in the mechanized mining of coal from the standpoints of use, construction, operation, and mechanical maintenance; classwork on related subjects of mechanics and strength of materials, and shopwork on each type of machine under consideration. Text material: Jones, D. C., Mechanized Mining Mechanics, and, Mechanized Mining Strength of Materials, Mineral Industries Extension Services, $1.25. Manufacturer's catalogues, 4 units.

MNG. 905X. MECHANIZED MINING ELECTRICAL APPLICATIONS: Intended for mine maintenance men but can be utilized as an upgrading program by other types of mine workers; provides the basic principles of proper and "permissible" operation of mechanized mining electrical equipment and proper maintenance procedure. Related mathematics and that portion of the mining laws of Pennsylvania governing the operation of electrical equipment in gassy coal mines are studied as related material. Textbooks: Jones, D. C., Mechanized Mining Electrical Applications, and, Mining Mathematics, Mineral Industries Extension Services, $5.00. Mining Laws of Pennsylvania, 9 units.

MNG. 906X. MECHANIZED MINING SUPERVISING COURSE: Designed for persons now serving in a supervisory capacity in a mechanized mine, or who expect to serve in a supervisory capacity, for the proper performance of their duties; group discussions under the guidance of a trained group leader, centering around the main topics of job instruction, time studies, operating cycles, operating control, and cost control. Basic background material is provided the group leader; there is no text material developed for student use, 3 units.

COAL PREPARATION

"Coal Preparation" was designed to meet the needs of workers who are engaged in both underground and surface beneficiation of coal. The depletion of higher quality coals, more exacting market requirements, and the introduction of mechanized loading devices that load any and all ma-
material shot down at the coal faces have given impetus to the development and more widespread use of cleaning plants. There is a growing need on the part of cleaning plant personnel for knowledge of fundamental principles of operation necessary to maintain the quality of product desired from each plant. The general purpose and coverage of the course is as follows:


MINE SURVEYING

Courses in mine surveying were developed at the request of industry to provide training of vocational grade to supplement on-the-job instruction of coal mine engineers, transit men, and chainmen. The customary procedure of developing mine surveyors through experience on the surveying corps is accelerated through their use, thus permitting a coal company to utilize men trained in this manner on jobs that would normally be assigned only to engineers of long and more varied experience. Thus, greater attention can be paid to jobs that should be supervised by engineers, and there is greater assurance of speedy and accurate mine surveys when all of the men on a corps have taken the courses in mine surveying.

Each course has been developed to operate on an average of 96 hours, thus making it possible to take the initial course one term and the final course the following term, or both courses can be taken the same term if the students are willing to put in the necessary hours. The general purpose and coverage of each course follows:

MNG. 908X. MINE SURVEYING I: The practice of mine surveying as it deals with the use of surveying instruments, simple surface and underground surveying practices, level and traverse computations, and drafting room practices. Mathematics relative to surveying is given as related material. Textbook: Breed, C. B., and Hosmer, G. L., *The Principles and Practice of Surveying, Volume I*, John Wiley and Sons, Inc., $4.50. 6 units.

MNG. 909X. MINE SURVEYING II: The use and adjustment of surveying instruments; advanced surface and underground surveying practices; the application of surveying methods to special mining problems such as haulage, exploratory drilling and ventilation. Mathematics and mining law are given as related material. Text material: Breed and Hosmer, *The Principles and Practice of Surveying, Volume I*, John Wiley and Sons, Inc., $4.50; *Mining Laws of Pennsylvania.* 6 units.

SPECIFIC APPLICATION MINING COURSES

Mineral Industries Extension Services will develop short noncredit courses for specific mining applications where the requests for any particular course warrants the expenditure of effort. Typical of this kind of work are the courses on Elementary Mine Surveying and Shotfirer’s and Machine Runner’s courses. The specific need of the applicant is served by a short course, whereas and longer and more involved coal mining or surveying course (which provides the same information at certain points in the training) might prevent the development of the class. Specific application courses are given in fee classes, with either the sponsoring company or the students taking care of all expenses in connection with the program. The following descriptions will show the coverage and general purpose of the two courses now available:

MNG. 910X. ELEMENTARY MINE SURVEYING: Provides foremen and other supervisors of small coal mines with the knowledge necessary to use a transit in running levels and in turning angles or projecting lines to keep the mine workings reasonably accurate between the semi-annual surveys made by a licensed engineer or surveyor. It consists of instruction on the adjustment and operation of the transit, and in running simple surface and underground surveys. Calculations are kept to a minimum since this is not a regular surveying course. No text materials are used.

No credit.

MNG. 911X. SHOTFIRER’S AND MACHINE RUNNER’S COURSE: Provides the training needed by men who desire to take the examination for a shotfirer’s or machine runner’s certificate as required by the Pennsylvania Bituminous Mining Laws. Instruction in the duties of the shotfirer and machine runner according to mining law, safety lamp construction and use, mine gases, detection of mine gases, and a review of questions used on previous examinations. A refresher course for men who have obtained similar certification previously but need additional training to insure proper performance of their duties. Training groups are limited to approximately 20 men. No text materials are used.

No credit.
NATURAL GAS

The petroleum and natural gas fields of Pennsylvania produce about four per cent of the total natural gas used in the United States. This quantity is not sufficient to supply the demands in the State, and as a consequence a large quantity is imported from other gas fields.

Large consumer demand has forced the gas industry in the State to develop its existing properties, search continually for new producing reservoirs and strive for more efficient utilization of transmission and distribution facilities. Increased production, transmission, and distribution must rely to a considerable extent upon improved engineering methods, whose efficiency will be low unless the worker who operates them is trained to handle the improvements. Courses in natural gas engineering give the workman in the industry basic technical training that will be of value to him in his work, and increase his value to the company by which he is employed.

PET. E. 901X. NATURAL GAS ENGINEERING FUNDAMENTALS: The fundamentals of mathematics, physics, and inorganic chemistry, the history and development of the industry, and the properties and testing of petroleum products. No prerequisites, but graduation from a four-year high school is desirable. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Engineering, Volume I, Mineral Industries Extension Services, $3.50. 9 units.

PET. E. 902X. EXPLORATION AND DRILLING: Exploration, drilling, and development of petroleum and natural gas reservoirs, petroleum geology, geochemical and geophysical prospecting, rotary and cable-tool drilling, well testing and completion, reservoir behavior, secondary recovery, fundamental geology, petroleum mineralogy, lease and leasing, and chemical and physical properties of petroleum and natural gas. Prerequisite: Pet. E. 901X. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Production, Volume II, Mineral Industries Extension Services, $4.00. 9 units.

PET. E. 903X. NATURAL GAS ENGINEERING: Practical engineering training in gas handling practices for men employed in the natural gas industry. The course is divided into three sections. The first includes the early history and economics of the industry, completion and operation of gas wells, elimination of gas hydrates, maintenance of gas wells, measuring the capacity and estimating the value of gas properties. The second in-
Thus, not only must the management and research divisions of the refining industry be familiar with the new processes and methods, but the operators in the plants must also know something about the technical and engineering sides of the processes which they are running.

This curriculum trains refinery employees in the latest processes used in the refining industry, fits them into the rapidly changing industry with more confidence and ability than the untrained workman, and makes them more valuable to themselves and to the industry.

PET. E. 904X. PETROLEUM REFINING ENGINEERING FUNDAMENTALS: Petroleum refining engineering with problems specifically applied to this field including development and products of the petroleum industry, mathematics, physics, inorganic chemistry and introduction to petroleum and natural gas production. No prerequisites, but graduation from a four-year high school is desirable. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Engineering, Volume I, Mineral Industries Extension Services, $3.50.

9 units.


PET. E. 906X. PETROLEUM REFINING ENGINEERING: Practical engineering and applied basic laws of unit processing, including the design and operation of units and equipment. The course is divided into two sections: (1) fluid flow, pumps, valves, heat transfer, heat exchangers and advanced distillation; (2) the fundamentals of design of stills and pipe heaters, distillation units, cracking units, the operation procedures of the units. Instrumentation, automatic control, refrigeration and refinery corrosion are included. Prerequisite: Pet. E. 905X. Textbook: Stephens, M. M., Petroleum Refining, Volume III, Mineral Industries Extension Services, $3.50. 9 units.

PETROLEUM PRODUCTION

As in natural gas production, crude oil production in the State of Pennsylvania is below demand. New drilling and increased recovery from old fields through the use of secondary recovery methods is doing much toward making up the deficit between demand and supply. The use of new methods requires better trained workmen who are equipped with a technical and basic scientific background of the methods.

A three-year curriculum in Petroleum Production presenting the basic and fundamental training necessary to a thorough understanding of the newer oil production methods follows. The latter portion of the curriculum gives the worker an understanding of the latest methods of oil production.

PET. E. 907X. PETROLEUM PRODUCTION ENGINEERING FUNDAMENTALS: Petroleum production engineering with problems applied specifically to this field, including development and products of the petroleum industry, mathematics, physics, inorganic chemistry, and introduction to petroleum and natural gas production. No prerequisites, but graduation from a four-year high school is desirable. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Engineering, Volume I, Mineral Industries Extension Services, $3.50. 9 units.

PET. E. 908X. EXPLORATION AND DRILLING: Exploration, drilling, and development of petroleum and natural gas reservoirs, including petroleum geology, geochemical and geophysical methods, rotary and cable-tool drilling, well testing and completion, reservoir behavior and secondary recovery, fundamental geology, petroleum mineralogy, leases and leasing, and chemical and physical properties of petroleum and natural gas. Prerequisite: Pet. E. 907X. Textbook: Stephens, M. M. and Spencer, O. F., Petroleum and Natural Gas Production, Volume II, Mineral Industries Extension Services, $4.00. 9 units.

PET. E. 909X. OIL FIELD EXPLOITATION: The production phase of the petroleum industry, beginning with the completion of the field development and ending with transportation of the products to the market. The important work of oil field drainage, lifting methods, management of wells, secondary recovery of oil and the surface handling of crude petroleum is included. Prerequisite: Pet. E. 908X. Textbook: Uren, L. C., Petroleum Production Engineering—Oil Field Exploitation, McGraw-Hill Book Co., Inc., $6.00. 9 units.
MINERAL TECHNOLOGY

CERAMICS

The scope of ceramics is rarely understood by the general public, and frequently not even by those engaged in the included industries. From the academic standpoint, ceramics is the study of the silicates and related materials. Such a study necessarily involves the related technologies in metallurgy and fuels, and clearly illustrates the reason for ceramics, metallurgy, and fuel technology being considered together as mineral technology.

JAMES R. COXEY, Supervisor
Ceramics Extension

The technology of ceramics includes the extraction and preparation of ceramic raw materials, their properties, methods of fabrication, uses, and factors which govern present industrial procedures.

Ceramic industries include glass, refractories, enamels, whitewares, heavy clay products, portland cement, abrasives, and a number of others.

Pennsylvania is generously endowed with the ceramic raw materials and fuels necessary to the manufacture of these products, and since the middle of the 19th Century has been the leading producer of ceramic products. At present it has approximately one-fourth of all the silicate in-


dustries of the country, and it leads in the production of several of the most important products.

All industries are becoming increasingly more technical. Formerly an employee, by acquiring several years experience in a certain position, had a mastery of this type of work which would hold for the rest of his normal working years. Now in a period of a few years, he may witness a complete change of process, generally dictated by scientific or engineering research. To acquire a thorough working knowledge of a new process in a short time the practical man must have some technical aid.

The three-year curriculum in ceramics is an answer to a demand for the technical education of trained supervisors or employees filling key positions in the various ceramic industries. The diversity of this field has necessitated the provision of several specialized courses of study, each pertaining to one particular industry. Because all theory of the various ceramic processes is based on silicate technology, much of the fundamental material is the same regardless of the industrial process to which it is applied. Hence, these fundamentals are presented in the first two years. The third year consists of a specialized study of the particular industry in which the group is employed. All classes study the same texts during the first two years, but in the third year special texts are used which treat specifically the subject under consideration.

The method of presentation provides five separate three-year courses. They are: Heavy Clay Products, including the manufacture of building brick, face brick, hollow tile, sewer pipe, terra cotta, stoneware, and allied products; Whitewares, including hotel china, semiporcelain, sanitary ware, electrical porcelain, and white tiles; Refractories, including fire clay brick, silica brick, basic brick, and all types of special refractories; Glass, including glass containers, pressed and blown ware, plate glass, window glass, and special glasses; and Enamels, including the preparation of frits and the application of enamels to cast iron and sheet steel. At present no courses are offered for cements or abrasives.

The regularly organized ceramics classes in extension are so standardized that a student having taken his first year in one section of the State can remove to another section and take his second year's work there with full assurance that he has lost nothing by the transfer. This standardization greatly assists an employer in evaluating a prospective employee's education; the employee is equally benefited by being able to offer an employer his certification of satisfactory completion of a widely recognized educational program.
CER. 901X. FUNDAMENTALS OF CERAMICS: An introduction to the entire field of ceramics, the relation of the various ceramic industries to each other, practical mathematics, chemistry, physics, including electricity and mechanics. The first year is a preparation for the specialized studies of the second and third years. Textbook: McNamara, E. P., *Ceramics, Volume I*, Mineral Industries Extension Services, $3.00. 9 units.

CER. 902X. BASIC CERAMIC TECHNOLOGY: Part I—Raw materials; including elementary mineralogy, the occurrence, uses and properties of ceramic raw materials and raw material preparation, which includes grinding and mixing. Part II—the production, control, and application of heat; including temperature measurement by instruments and cones, fuels, and their combustion, and refractories for furnaces. Part III—silicate chemistry, including the interpretation of melting and crystallization diagrams for silicate mixtures. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.00. 9 units.

CER. 903X. APPLIED CERAMICS. Four industrial subject groups may be studied. They are: Clay Products and Whitewares; Refractories; Glass; and Enamels. The Clay Products and Whiteware groups use the same book for their third year but for the other groups separate books are provided.

Clay Products and Whitewares: for employees in either heavy clay products plants or whiteware plants. The work is given in three parts: Part I—general manufacturing processes, including clay forming, drying and driers, and firing and kilns; Part II—calculations and testing; including calculations for bodies and glazes, standard test procedures for various properties of clays and clay products and test apparatus; Part III—the properties and specifications of the heavy clay products, the properties and bodies of whiteware products, and glazes and glazing. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, $3.50. 9 units.


Enamels: The enameling industry and its raw materials, the melting and fritting of enamels, their application and firing on cast iron and sheet steel, the metallurgy of the irons and steels used for enameling. Textbook: Andrews, A. L., *Enamels*, Twin City Publishing Company, $5.50. 9 units.

FERROUS METALLURGY

The State of Pennsylvania is the leader in iron and steel production in the nation, and the interest of its state college in education programs to promote efficiency and knowledge of its workers in this field is a natural consequence. After thoroughly considering the needs and the average education level of the employees to be served, and consulting with industrial leaders, an organized four-year extension course in ferrous metallurgy has been designed and is now being offered. This course has, as its purpose, the correlation of practical experience with the more technical phases of the subject, thereby assisting the employer by providing an improved and better trained personnel, and the employee by increasing his available
knowledge and giving him the feeling of greater security in his job through increased knowledge.

The course covers the ferrous metallurgy field, from raw material to finished product, and reviews the fundamentals essential for an understanding of the more specific phases covered. The plan is to present basic principles and include the latest and most accurate data available. The material is presented in sequence; each volume presents advancing steps in processing and manufacture. The nature of the material covered makes it highly desirable that there be no break in the sequence of the outlined four years' work. The student should have as prerequisites, high school chemistry and physics. This does not preclude, however, a student not having such a background from studying the work; it merely means that more intensive study is necessary to understand the principles involved.


**MET. 902X. MANUFACTURE AND FABRICATION OF STEEL:** The Bessemer, open hearth, electric furnace, and special processes of steel making, the steel ingot; principles and general methods of fabrication; rolling mill practice; the manufacture of steel strip, sheet, tin plate, wire, tubular products, and structural shapes; general welding methods; forging practice; principles of the steel foundry. Prerequisites: Met. 901X. Textbook: Teichert, E. J., *Ferrous Metallurgy, Volume II*, McGraw-Hill Book Co., Inc., $4.50. 9 units.

**MET. 903X. PHYSICAL FERROUS METALLURGY:** Laboratory technique, non-destructive testing, physical testing, constitution of alloys, the iron-carbon diagram, the metallurgy of steel castings and cast iron, the mechanical treatment of steels, heat treatment of steels, theory of hardening, grain size, case hardening, general effects of alloying elements, alloy steels—both low alloy and special alloys such as stainless and tool steels—cast irons and their treatment. Prerequisites: Met. 902X, or graduation from a four-year high school course including chemistry and physics. Textbook: Teichert, E. J., *Ferrous Metallurgy, Volume III*, McGraw-Hill Book Co., Inc., $5.50. 9 units.