

Pennsylvania's School of Mineral Industries and Experiment Station



Dedicated to education in mineral conservation and research by which the means may be found to make conservation effective. This includes diligent search for mineral truths and the energetic discovery, complete extraction, and maximum utilization of irreplaceable mineral resources.

FIELDS OF WORK

GEOTECHNOLOGY

EARTH SCIENCES: Geology, Mineralogy, Geophysics, Geochemistry, Meteorology, and Geography.

MINERAL ENGINEERING: Mineral Economics, Mining, Mineral Preparation, and Petroleum and Natural Gas.

MINERAL TECHNOLOGY: Fuel Technology, Metallurgy, and Ceramics.

DIVISIONS OF SERVICE

Resident Instruction

Extension Instruction

Correspondence Instruction

Mineral Industries Research



THE PENNSYLVANIA STATE COLLEGE BULLETIN

VOLUME XLV

July 13, 1951

NUMBER 28

Published weekly from January to August inclusive and monthly from September to December inclusive. Entered as second-class matter at the Post Office, State College, Pa., under Act of Congress of August 24, 1912.

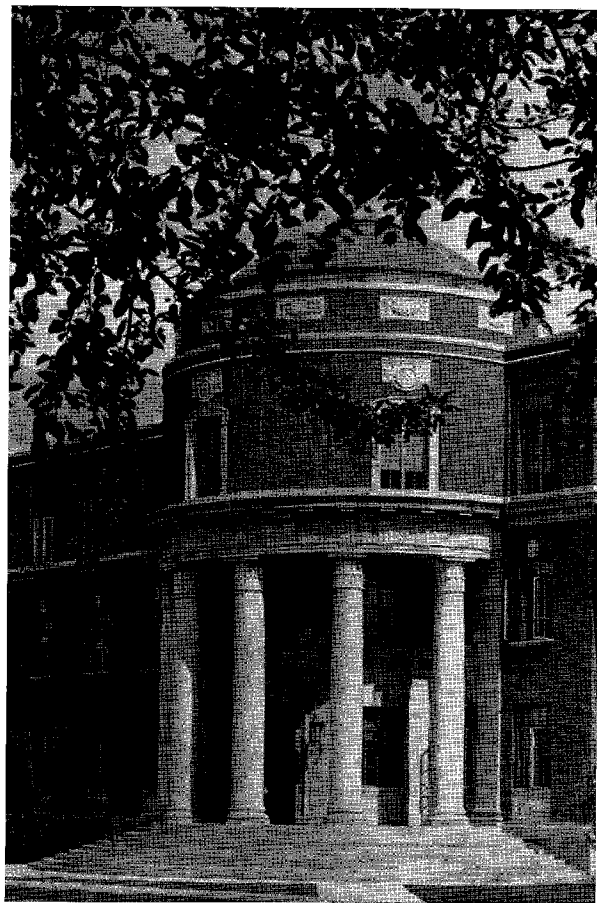
STATE COLLEGE, PENNSYLVANIA

Mineral Industries Extension



and Correspondence Instruction

Circular No. 38



ENTRANCE OF THE MINERAL INDUSTRIES BUILDING

Contents

	Page
Foreword	6
Mineral Industries Extension Services	8
Mineral Industries Extension Services Staff	12
MINERAL INDUSTRIES EXTENSION INSTRUCTION	
Scope of the Work	13
Cooperation with State Agencies	13
Class Organization and Control	14
Courses, Curricula and Credits	15
Assistance in Class Organization Provided	17
COLLEGE-CREDIT EXTENSION COURSES	19
INDUSTRIAL TYPE EXTENSION COURSES	20
Mining Extension	20
Petroleum and Natural Gas Extension	24
Ceramics Extension	27
Fuel Technology Extension	29
Metallurgy Extension	29
Supervisory Extension Training	32
MINERAL INDUSTRIES CORRESPONDENCE INSTRUCTION	
Procedures to be Followed, and Other Information	33
CORRESPONDENCE COURSES	
EARTH SCIENCES	
Geography	39
Geology	40
Geophysics	41
Meteorology	41
Mineralogy	43
MINERAL ENGINEERING	
Mineral Economics	43
Mining	43
Natural Gas Engineering	44
Petroleum Refining Engineering	45
Petroleum Production Engineering	46
MINERAL TECHNOLOGY	
Ceramics	46
Fuel Technology	48
Metallurgy	48
Textbooks and Their Costs	50
Addresses of Publishers of Textbooks	51

Mineral Industries Extension Services The Pennsylvania State College

THIS BULLETIN DESCRIBES THE COURSES in the field of the mineral industries that are available through extension instruction or by correspondence.

Courses offered through extension classes are limited to Pennsylvania. They are generally "industrial type" courses by reason of their subject matter, method of presentation, and specific utilization. Industrial type

Inquiry from any mineral industry or any mineral industries worker in Pennsylvania requesting information on the formation of an extension class program will receive prompt attention. Mineral Industries Extension Services are prepared to provide complete assistance in organizing classes to meet the training needs of the individual, the group, or the community.

extension courses are designed to be of immediate value to men working in the various mineral industries, and the credits granted for completion of any particular course are termed "industrial" credits. In certain curricula completion of certain designated courses is rewarded with an industrial grade diploma. Informal class instruction in subjects for

which credits are not given is also available, while classes in college-credit courses will be developed where there is sufficient demand.

Courses offered through correspondence are available to individuals in other states and foreign countries as well as to residents of Pennsylvania. The industrial grade courses parallel those offered in extension classes, and the credits granted for completion of either a single course or a curriculum are equivalent to those secured through class instruction. Credits toward an industrial grade diploma may be secured by a combination of extension and correspondence instruction.

Completion of a college level correspondence course is rewarded by granting credits that are applicable toward a baccalaureate degree.

Extension Curricula:

Coal Mining
Ferrous Metallurgy
Natural Gas Engineering
Petroleum Production and Petroleum Refining

Short Courses:

Coal Preparation
Fuels and Combustion
Glass Technology
Heavy Clay Products
Mechanized Mining Electrical Applications
and Mechanical Maintenance
Mine Surveying
Physical Metallurgy
Refractories
Supervisory Training
Whitewares

Correspondence Courses:

Ceramics
Climatology
Coal Mining
Ferrous Metallurgy
Fuels and Combustion
Geography
Geology
Geophysical Prospecting
Mechanized Mining Electrical Applications
Meteorology
Mineralogy
Mineral Economics
Natural Gas Engineering
Petroleum Production
Petroleum Refining
Physical Metallurgy

Data:

pertaining to the
administration of the work.

Foreword



EDWARD STEIDLE, *Dean*

THE SCHOOL OF MINERAL INDUSTRIES, an integral part of The Pennsylvania State College, 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 non-metallic minerals. The mineral arts and sciences likewise fall naturally into three distinct groupings of subject matter: (1) the *earth sciences*, including geology, mineralogy, geography, geophysics, geochemistry, 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. The 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 of service—resident instruction, extension and correspondence instruction, and research. The second of these functions, extension and correspondence instruction, finds expression through the Extension Services. In order that the extension program may benefit from the interest and cooperation of the faculty, which is concerned in all three functions, the Extension Services has been set up, not as an independent organization, but as the organized expression of an important function of the 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. Through this service the principles and truths developed through study and research are translated and car-

ried to the people and applied to the industries. Educational processes taken into the mines, mills, and plants result in the promotion of a mutual understanding between employers and employees which is imperative for efficiency, safety, and economy of operation. The Extension Services are so organized as to spend their funds at the cutting edge of their program of service. The School of Mineral Industries is the only educational institution of the Commonwealth that carries on extension and correspondence instruction in the field of mineral-extractive and primary processing industries. The program is in keeping with the intent of the organic Land-Grant Act.

This bulletin, prepared by D. C. Jones, Director, Mineral Industries Extension Services, describes briefly the development and the function of the Extension Services, its policies, and the facilities and courses of study that are available. Inquiries regarding either extension or correspondence instruction should be addressed to the Director.

EDWARD STEIDLE, *Dean*
School of Mineral Industries

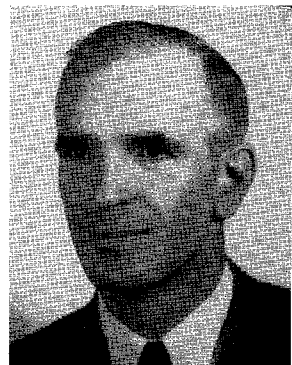
Mineral Industries Extension Services

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 developed because of the enactment of mine laws and regulations in Pennsylvania requiring certification of underground officials. So far as the records reveal, this was the first organized extension training program in the United States.

Between 1894 and 1899, 27 extension bulletins were printed and distributed free to men in the mining industry. The records show also that a series of free lectures was delivered by mining department personnel "to the mining employees at their customary places of assembly upon matters of interest to them in their occupation."

In 1899 legislative action reduced the College appropriation, and the mining extension work had to be curtailed in proportion. From 1903 to 1915 extension classes in coal mining were conducted by mem-

bers of the resident faculty in the anthracite region and in the bituminous coal area of Central Pennsylvania in cooperation with and through funds provided jointly by 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 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 extension instruction had been



D. C. JONES, Director

given by resident mining department staff members, but now a full-time extension man was employed to develop the extension program in mining, and this method of operation prevailed for the next twelve years.

In 1931 the extension activities of the School were placed on an organized basis compatible with the unified program of the newly reor-

ganized School of Mineral Industries and a director was appointed to take charge of the work. The objective of the extension division was defined as "carrying a program of education and training to *mineral industries* workers throughout Pennsylvania." There is a peculiar responsibility of educating promising young men into the mineral industries directly following high school. In the succeeding years adherence to this policy has resulted in the development of a program that parallels the work given in resident instruction by the School and that now provides (1) basic, on-job, vocational-technical, upgrading industrial type extension curricula; (2) short, specialized, terminal extension courses; (3) college-credit extension courses, where warranted; and (4) correspondence courses of (a) college level and carrying college credits, and (b) of industrial type and carrying "industrial" credits. The extension programs are limited to residents of Pennsylvania, but the correspondence courses are available to any person, whether a resident of Pennsylvania or some other state or country.

An important phase in the development of the extension work was the agreement, reached during the first year of the reorganized program and approved jointly by the State Department of Public Instruction and the College, whereby extension classes in the field of the mineral industries could be organized throughout the Commonwealth under "public supervision and control," with the State Department of Mines and the State Department of Labor and Industry collaborating. It was further decided at this conference to organize all vocational extension classes on a three-year basis, with a textbook to cover each year of instruction.

The initial application of this three-year program was in coal mining. The mass of instruction pamphlets and lesson material that had been in use for a number of years was reorganized and printed in textbook form in 1932. Through constant attention to revision where new processes have been developed, these texts now occupy an enviable position in the mining literature that is applicable not only in Pennsylvania but in other areas where training of mine officials is essential.

A program of training for workers in the petroleum and natural gas industries was also initiated in 1932. Three textbooks were prepared, originally to cover the entire field of worker instruction. As more experience was gained in the educational needs of the different employees, the text material was reorganized and expanded to cover three curricula in Natural Gas Engineering, Petroleum Production, and Petroleum Refining.

Training programs for the ceramic and metallurgical industries were organized in 1933, and in the succeeding years three textbooks were developed for each program. Recently, a fourth ceramics text on refractories has been published. The metallurgy texts have been used with considerable success in carrying out the unified three-year program as origi-

nally envisioned, while the ceramic texts now provide instruction under four options in the ceramics field, with common texts for the preparatory work.

The development of short terminal courses started with a request in 1940 for instruction of miners who needed training in the operation and maintenance of equipment utilized in coal mines under so-called "mechanized mining" operations. Four short courses were developed and the instruction material was printed in mimeographed form for use of the students. Similar short-course work was developed in 1942 for men in coal preparation plants, and in 1946 the demand for training of mine surveying corps members resulted in the development of a course for this type of worker. In 1947 training of mine supervisory personnel by the "conference" method was initiated. The short course lends itself to training of mineral industries workers where the longer curriculum in some particular field does not provide the intensive training required in some specific application.

The development of text material for use in class and correspondence instruction has been necessary because of the lack of training texts designed specifically for the type of instruction needed. In some courses, notably the short course programs, where suitable texts are available, no attempt is made to duplicate this material. All textbooks published by the Extension Services are reviewed critically and revised, where that is deemed essential, when reprinting is necessary, which may occur every year in the case of certain texts, and every two or three years for other texts.

The organization plan of the Extension Services is peculiar to the School. The over-all direction of the extension work is the responsibility of the director. A supervisor, corresponding to a resident department head or chief, is responsible for the direction of the work in his particular subject-matter field. This work consists of the organization of extension classes and supervision of the instruction and operation of these classes during the term. He is also responsible for the development of suitable text material for use in both class and correspondence instruction. In all of this work the supervisor may be assisted by one or more assistant supervisors, depending on the extent of the program. The necessity for knowing the educational needs of the workmen in his particular industry requires frequent contacts with industrial and educational leaders. In order to keep abreast of the most recent industrial developments, the supervisor must visit the mines, plants, or mills frequently; and he must also attend institutes and other educational meetings. All supervisors have had industrial experience, and in the mining extension group members of the staff are certified by the State of Pennsylvania to serve as underground mine officials.

The scope of the extension training conducted in the field of the mineral industries prior to 1931 cannot be ascertained due to lack of records. In the period from 1931 to 1951, the Extension Services has provided training in mineral industries courses to 58,697 Pennsylvania workers through extension classes and to 1799 persons through correspondence courses. In addition, 7138 persons were provided training in college level courses in classes conducted during the period 1941-44 in Defense and War Training programs by the College under the sponsorship of the U. S. Office of Education. The grand total of persons trained by Mineral Industries Extension Services during the period 1931-51 is, therefore, (a) regular extension and correspondence instruction—60,496, (b) defense and war training—7138, or a grand total of 67,634 and an average over the 20-year period of 3382 persons annually. Recent surveys indicate that students from approximately 570 communities in 41 of the 67 counties in the Commonwealth are provided training in mineral industries extension classes.

Training in mineral industries subjects is available to any person or group of persons in Pennsylvania through extension classes or through correspondence instruction. Mineral Industries Extension Services is prepared to provide this service to meet not only the demands of industrial workers for existing courses but also requests for the development of new courses and programs that arise from the current needs of industry for better trained workmen.

Mineral Industries Extension Services Staff

EDWARD STEIDLE, *Dean, School of Mineral Industries*

DONALD C. JONES, *Director, Extension Services*

HARRY B. NORTHRUP, *Professor Emeritus*

Mineral Technology

LOUIS F. HALLER,
*Assistant Professor**
FREDERICK R. AXELSON**
Two positions vacant

Mining

JOSEPH W. HUNT,
*Associate Professor**
MYLES E. ALTIMUS, JR.,
Assistant Professor
JAMES V. SICKLESMTIH,
Instructor
JOSEPH L. WALKER, JR.**

Supervisory Training

ROBERT B. HEWES,
*Associate Professor**
MILES BLOOM, *Instructor*
MICHAEL ZULKOSKI, *Instructor*

Petroleum & Natural Gas

OSCAR F. SPENCER,
*Associate Professor**

Mineral Industries Extension Instruction

SCOPE OF THE WORK

Mineral industries extension instruction is off-campus training in the adult education field. The primary purpose of such instruction is to provide training for the mineral industry workers of the Commonwealth of Pennsylvania, and the majority of courses offered have been designed to provide such training on the level of "worker understanding" or are of the industrial type. Courses offered in resident instruction are also available through extension; and where there is sufficient demand for such college-credit courses, they are established and operated for the benefit of the requesting group.

The industrial training program is by far the largest part of the extension instruction service. Its general purpose is to upgrade mineral industries workers and encourage self-development and advancement through study. More specific objectives are (a) providing basic educational courses that will serve as a foundation on which each student may build the more advanced courses of specific application, (b) preparation of men for examinations that may be required in a particular industry, (c) providing specialized training for particular jobs where technical knowledge is essential, and (d) preparation of individuals to understand and appreciate constantly changing industrial practices.

COOPERATION WITH STATE AGENCIES

The industrial type courses offered by Mineral Industries Extension Services are provided in classes that may differ as to method of control. By far the greater number of classes are operated under "public supervision and control" or conducted under the direct control of the school board of some school district, with the approval of the State Department of Public Instruction, and with the Extension Services aiding in the class development and in its operation through "subject-matter supervision."

The authority for such operation dates back to August, 1931, when the College entered into an agreement with the State Departments of Public Instruction, of Mines, and of Labor and Industry whereby the College, as the recognized leader of mineral industries education in the State, was given the responsibility for development of extension lesson material and supervision of extension classes using this material. The State Department of Public Instruction, which administers the State and federal funds allocated to Pennsylvania for vocational education, agreed to cooperate in the forming of evening trade extension classes in mineral

* *In Charge.*

** *On leave of absence—in the armed services.*

industries subjects under the immediate jurisdiction of local public school systems. Throughout the years since that agreement, this cooperative operation has been responsible for the establishment of classes in practically every city and town of any size in the State that depends, either wholly or in part, on some mineral industry for its support.

CLASS ORGANIZATION AND CONTROL

Classes offering industrial type courses which are organized under the Mineral Industries Extension Services program may be grouped according to the method of organization and control employed. Group A, by far the largest in number, consists of classes organized cooperatively with the State Department of Public Instruction and local school boards. Group B includes classes organized along the same lines as the first group, but with industry cooperating financially. Group C consists of classes organized by the College for a particular company or group of companies, and with full control vested in the cooperating agencies.

Organization of a class in cooperation with the State Department of Public Instruction and any local school board must conform to the requirements of the Pennsylvania School Law. A petition, signed by 20 or more residents of the school district, must be presented to the school board which must act on the petition. Approval is followed by a request from the board to the State Department of Public Instruction for authorization to operate a class, details of which are included with the request. At the same time the application for a teaching certificate for the individual who has been selected by the board to teach (usually following recommendation by the College) is forwarded to the Bureau of Teacher Education and Certification. Approval of the class is usually granted if the petition of the board is in order, the applicant for the teaching job is properly qualified, and the course of study is on the list of courses approved by the State Department of Public Instruction. All courses offered by the Extension Services in classes of this type have been approved by that Department.

The local school board must, according to the Pennsylvania school laws, provide a meeting place and the necessary light and heat for the class. These are "free" evening trade extension classes and no tuition is charged the students, but they are required to purchase text materials and class supplies. Supervision of the subject matter and its presentation in class is a responsibility of the Extension Services. Supervision of class operation is vested in the local school board and its authorized operating officials. According to school law, classes of this type may be closed if the attendance falls below 10 for six consecutive sessions.

A teacher of a school board class is paid by the board throughout the term. At the close of the school year, the board submits a report on the class operation and expenditure of funds for instruction to the State Department of Public Instruction which, in due time, reimburses the local board for the teaching expense. Any other expense, as for light, heat, janitorial service, etc., that may be incurred through operation of the class is not reimbursable. Funds for reimbursement are provided by both the State and federal governments for vocational classwork of the type described.

Group B classes differ from those in Group A only in the matter of financial responsibility on the part of the local agencies interested in promoting such classes. The Pennsylvania School Laws provide for subsidy by industry of a class organized and operated by a local school board for the benefit of employees in that industry. This subsidy is necessary only when reimbursement of instructional expenditures by the State Department of Public Instruction is less than the amount actually expended, and the local school board is unable to assume the financial burden of the difference. Funds given by an industry to a local school board are not reimbursable directly to the industry. However, in those instances where industry has advanced the entire amount of money expended for instruction, the local school board returns to industry that amount reimbursed to them by the State. In all other respects classes in this group are organized and controlled in the same manner as in Group A.

Group C or "private industrial" classes are organized in cooperation with a company or group of companies whenever there is a demand for training. Arrangements for the class, the selection of the instructor, and other details of operation are worked out between the College and the company or companies served. Instructors may be paid by the sponsoring company, or may be paid by the College which, in turn, is reimbursed by the sponsoring organization. Classes may be "free" to students, or they may be "fee" classes in which either a part or all of the operating expense is paid by the students. Meeting places and other facilities may be provided by the sponsoring organization, or these may be rented by the College and the expense incurred added to the other operational costs.

COURSES, CURRICULA, AND CREDITS

The industrial type of course offered by Mineral Industries Extension Services may be classified (a) as to whether or not it is a part of a curriculum, and (b) whether or not credits are granted for completion.

Industrial type courses offered in extension that are approved by the College Senate carry numbers in the 900 series, plus an X to indicate that they are approved for extension. Certain courses have been grouped

into curricula so as to present complete studies for particular industrial groups; in each case the initial material offered is of a preparatory nature, followed by courses arranged in a logical ascending order of importance. Other courses which are related to but are not necessarily a part of a curriculum have been provided to give "specific" training in certain subjects. These specific training courses are also known as "terminal" courses because they are complete studies and not necessarily preparatory to some advanced course. In certain cases terminal courses are given to classes after they have completed their particular curriculum.

Many industrial training needs are satisfied by courses designed to fit each particular situation. Since these courses are not, as a rule, subject to standardization, they are not offered to the College Senate for approval and they do not carry numbers. Work of this type is termed "informal" instruction. Occasionally informal instruction courses may become standardized sufficiently to permit their use in a number of locations, and when this occurs they are offered to the Senate for approval and eventually are listed either as terminal courses or as parts of curricula.

Every industrial type course carrying a number, indicating Senate approval, also carries credits which vary in number depending on the course length. These credits are termed "units" to avoid confusion with "college credits" applying toward baccalaureate degrees. One unit of credit is granted for 16 hours of class instruction. Courses offered by Mineral Industries Extension Services are designed to operate for 64, 72, 80, 96, and 144 hours per term, so the units of credit vary from 4 to 9 per course.

Completion of any course carrying credits merits a certificate indicating the number of units earned; completion of a curriculum is rewarded by the granting of an "industrial type" diploma. Completion of an informal instruction course is rewarded by the granting of a certificate showing the hours of attendance.

The arrangement of class schedules to provide the indicated number of hours of class instruction per term is a matter that is determined jointly by the Extension Services and the class instructor. A common class schedule consists of two sessions per week, 2½ hours per session, with classes starting either in September or early October and closing in April or May of the following year. Some class groups with shorter courses meet only once each week; others may meet twice each week and complete a course in several months, starting any time throughout the school term.

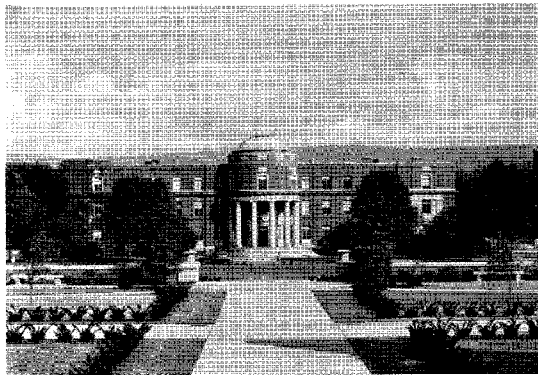
Courses offered in resident instruction can also be given in extension provided they are of such a nature that off-campus instruction of a quality comparable to resident instruction can be secured. Instructors

must be approved by the chiefs of the resident instruction divisions involved, and class facilities must likewise meet the approval of these chiefs. College credits earned in extension may be applied toward a baccalaureate degree within the limits placed on the earning of such credits by the College.

ASSISTANCE IN CLASS ORGANIZATION PROVIDED

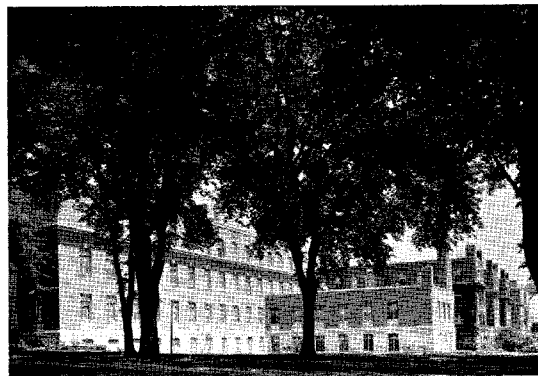
Mineral Industries Extension Services will assist any group of mineral industries workers in Pennsylvania in the establishment of a training class to meet their specific needs. Likewise, requests from companies, from officials of any State agency, from technical societies, or from individuals to make a survey to determine the need for establishment of a training class or classes will be given immediate consideration. All inquiries concerning extension training in the mineral industries should be directed to

D. C. JONES, *Director*
Mineral Industries Extension Services
THE PENNSYLVANIA STATE COLLEGE
State College, Pennsylvania



UPPER PHOTOGRAPH SHOWS THE MINERAL INDUSTRIES BUILDING, ADMINISTRATION BUILDING OF THE MINERAL INDUSTRIES GROUP. IN THE BACKGROUND IS MOUNT TUSSEY.

IN THE LOWER PHOTOGRAPH IS A VIEW OF THE MINERAL INDUSTRIES GROUP AS SEEN FROM THE SOUTH. AT THE LEFT IS THE NEW MINERAL SCIENCES BUILDING.



College-credit Extension Courses

College-credit courses offered in resident instruction are also available in extension provided (a) that facilities comparable to that required for offering each course in residence are available for offering it in extension, (b) that the students comprising the group desiring the course have the necessary prerequisites, and (c) that there is a sufficiently large number of registrants to insure the financial success of the class, since these are fee courses.

College-credit courses in extension have been most useful to public school teachers who desire the credits for certification. *Geography 26, Economic Geography*, has been given in a number of locations. Other courses in the geography and geology fields that are listed as correspondence courses in this circular could be made available to such groups if they so desired.

Industrial groups that would like to have some particular college-credit course offered in extension can secure that service provided the conditions stipulated in the first paragraph of this section can be met. One such course, *Ceramics 413, Ceramic Petrography*, was given to a group of industrial people in the Philadelphia area several years ago.

The college-credit courses that are currently listed as approved for extension are as follows:

GEOG. 26. ECONOMIC GEOGRAPHY: The geography of the world's commodities and their regional aspects; land uses, extractive and manufacturing industries and their natural and cultural relationships. Textbook: Jones, C. F., and Darkenwald, G. G., *Economic Geography*, 1st ed., The Macmillan Company, \$5.50.

Lecture 3 hours per session, 16 sessions.

Fee \$30; 3 college credits.

CER. 413. CERAMIC PETROGRAPHY: Petrographic microscopy and related analytical techniques applied to the study of ceramic materials and the reaction products of firing processes. Prerequisites: Cer. 303, Min. 460. Textbooks: Winchell, A. N., *Microscopic Characters of Artificial Minerals*, 2nd ed., John Wiley and Sons, Inc., \$6.00; Larsen, E. S., and Berman, H., *The Microscopic Determination of the Nonopaque Minerals*, U.S.G.S. Bulletin 848, \$0.50. Lecture 1 hour, practicum 6 hours per session, 16 sessions.

Fee dependent on size of class; 3 college credits.

Industrial Type Extension Courses

The industrial type extension courses offered by Mineral Industries Extension Services are classified under two major divisions, paralleling the classification of courses in resident instruction. These are the *mineral engineering* and *mineral technology* divisions of subject matter; there are no extension classes offering industrial type *earth sciences* courses.

Mineral engineering courses are divided into *mining extension* and *petroleum and natural gas extension* programs, with courses in each designed to provide training in some phase of each industry.

Mineral technology courses are divided into *ceramics extension*, *fuel technology extension*, and *metallurgy extension* programs. Both ceramics and fuel technology find wide application in the metallurgical field; so there is a close relationship in the operation of the three extension programs. Ceramics and fuel technology courses also find wide application in their own particular industries.

Mining Extension

The mining extension program consists of a three-course curriculum in coal mining, plus short credit courses in mechanized mining, coal preparation, and mine surveying.

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 those in the second course, and these in turn are preparatory for the third course studies.

MNG. 901X. 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. Includes basic studies in mathematics, geology, coal resources, 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 prepares for the fire boss certificate examination. Textbooks: Jones, D. C., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Hunt, J. W., *Coal Mining, Volume I*, 3rd ed., \$4.00, Mineral Industries Extension Services. *Mining Laws of Pennsylvania*. 144 hours, 9 units.

MNG. 902X. INTERMEDIATE COAL MINING: Includes basic studies in mathematics, advanced mine ventilation, combustion and oxidation, mine fires, mine explosions, rock dusting, mine rescue and recovery work, explosives and blasting, mine timbering methods, mine drainage, and compressed air. This course prepares for the mine foreman certificate examination. Prerequisite: Mng. 901X. Textbooks: Jones, D. C., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Hunt, J. W., *Coal Mining, Volume II*, 3rd ed., \$4.00. Mineral Industries Extension Services. 144 hours, 9 units.

MNG. 903X. ADVANCED COAL MINING: Includes expression aids for the supervisor, mining methods (anthracite and bituminous), equipment, ventilation practices, underground transportation, and electricity. 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. Textbooks: Jones, D. C., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Hunt, J. W., *Coal Mining, Volume III*, 3rd ed., \$4.50, Mineral Industries Extension Services. 144 hours, 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. 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*. 64 hours, 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., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Altimus, M. E., *Mechanized Mining Electrical Applications*, 2nd

ed., \$1.50, Mineral Industries Extension Services. *Mining Laws of Pennsylvania*. 144 hours, 9 units.

COAL PREPARATION

The coal preparation course 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 mining and loading devices that load all of the material extracted or 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:

MNG. 907X. COAL PREPARATION: A survey of coal preparation both inside and outside the mine, cleaning methods in most prominent local use, modern cleaning methods, flow sheets, post-cleaning treatment of coal, calculations and reports, processing other than carbonization, and froth flotation. Related mathematics is included as part of the course work. Text material: Jones, D. C., *Mining Mathematics*, 2nd ed., Mineral Industries Extension Services, \$1.75. *Manufacturer's Catalogues*. U. S. Bureau of Mines publications. 144 hours, 9 units.

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 supplemented and accelerated through class instruction, 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. Also, 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*, 8th ed., John Wiley and Sons, Inc., \$4.50. 96 hours, 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*, 8th ed., John Wiley and Sons, Inc., \$4.50; *Mining Laws of Pennsylvania*. 96 hours, 6 units.

Petroleum and Natural Gas Extension

Three different three-course curricula covering the fields of natural gas, petroleum refining, and petroleum production constitute the work in petroleum and natural gas extension. These courses have been utilized widely by industry, through classroom and correspondence instruction in Pennsylvania and by correspondence instruction throughout the rest of the United States.

NATURAL GAS ENGINEERING

Large demands for natural gas have forced the gas industry in the State to develop more extensively existing properties, search continually for new producing reservoirs, and strive for more efficient utilization of transmission and distribution systems. Courses in the natural gas engineering curriculum give the employees in that industry basic technical training and improved engineering methods that are necessary in developing an expansion program.

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*, 2nd ed., Mineral Industries Extension Services, \$1.00. 144 hours, 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, introduction to 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*, 2nd ed., Mineral Industries Extension Services, \$1.50. 144 hours, 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 four sections. The first includes natural gas economics, measuring properties of natural gas, and gas well completion. The second includes gas gathering, compression, and transmission. The third includes gas measurement and regulation. The fourth includes natural gasoline manufacturing and cycling, and stabilizers and stabilization. Prerequisite: Pet. E. 902X. Textbook: Stephens, M. M. and Spencer, O. F., *Natural Gas Engineering*, 2nd ed., Mineral Industries Extension Services, \$4.50. 144 hours, 9 units.

PETROLEUM REFINING ENGINEERING

The petroleum refining industry, under normal conditions, probably changes more in a given period of time than any other industry. Millions of dollars are spent each year on research and development work that constantly alters current processing methods. Not only must the management and research divisions of the refinery be familiar with the new processes, but also the plant operators and mechanical maintenance men must know something about the technical and engineering sides of the processes with which they work. This curriculum provides training for 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*, 2nd ed., Mineral Industries Extension Services, \$4.00. 144 hours, 9 units.

PET. E. 905X. UNIT PROCESSING: Includes organic chemistry, crude oil evaluation, petroleum refining equipment, refining by distillation, natural gasoline manufacture, stabilizers and stabilization, thermal cracking, alkylation and polymerization, catalytic refining, refining by use of chemicals, adsorption, crystallization, lubricating oil additives and blending, lubricating grease manufacture, refinery control laboratory, and storage of gasoline and oil. Prerequisite: Pet. E. 904X. Textbook: Stephens, M. M. and Spencer, O. F., *Petroleum Refining, Volume II*, 2nd ed., Mineral Industries Extension Services, \$4.50. 144 hours, 9 units.

PET. E. 906X. PETROLEUM REFINING ENGINEERING: Covers refinery products and test methods, evaluation of oil stocks, physical properties of petroleum oils, fluid mechanics, combustion, vaporization and condensation, fractionation and towers, heat transfer and exchangers, tube-still heaters, economics of design, and typical design calculations. Prerequisite: Pet. E. 905X. Textbook: Nelson, W. L., *Petroleum Refining Engineering*, 3rd ed., McGraw-Hill Book Co., Inc., \$9.00. 144 hours, 9 units.

PETROLEUM PRODUCTION ENGINEERING

During the past few years the petroleum production industry has devised new engineering methods to obtain more crude petroleum from existing reservoirs, and to develop new reservoirs for maximum oil recovery. New drilling and increased recovery from petroleum producing fields through the use of secondary recovery methods are doing much to keep the refineries supplied with crude. The use of new production methods requires better trained employees who are equipped with a technical and basic scientific background of these methods. Petroleum production courses cover the latest scientific production methods and offer a means of training employees in this increasingly expanding industry.

PET. E. 907X. PETROLEUM PRODUCTION ENGINEERING FUNDAMENTALS: Petroleum production engineering fundamentals with problems applying specifically to this field, including mathematics, physics, and inorganic chemistry. 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*, 2nd ed., Mineral Industries Extension Services, \$4.00. 80 hours, 5 units.

PET. E. 908X. PETROLEUM PRODUCTION TECHNOLOGY: Petroleum mineralogy, formation, classification and properties of sedimentary rocks, origin and migration of petroleum and natural gas, structural geology, exploration for petroleum and natural gas, drilling practices, well testing and

completion, reservoir efficiency and well spacing, and introduction to secondary recovery. Prerequisite: Pet. E. 907X. Textbook: Stephens, M. M., and Spencer, O. F., *Petroleum and Natural Gas Production*, 2nd ed., Mineral Industries Extension Services, \$4.50. 80 hours, 5 units.

PET. E. 909X. SECONDARY RECOVERY OF OIL: Covers secondary recovery of oil by water flooding and injected gas drive. Topics include geological factors, reservoir susceptibility, well spacing and flood patterns, water source and purification, design and operation of plants, correcting a heterogeneous permeability profile, reconditioning wells, estimating costs. Prerequisite: Pet. E. 908X. Textbook: Spencer, O. F., *Secondary Recovery of Oil*, Mineral Industries Extension Services, \$4.50. 80 hours, 5 units.

Ceramics Extension

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 viewpoint, ceramics is the study of the silicates and related materials; such a study necessarily involves the related technologies in metallurgy and fuels. 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.

Pennsylvania has been generously endowed with the ceramic raw materials and fuels necessary for the manufacture of glass, refractories, enamels, whitewares, heavy clay products, portland cement, abrasives, and a number of other ceramic products. Since the 19th century this State has been the leading producer of ceramic products in this country, having at the present time approximately one-fourth of the silicate industries, and leading in the production of several of the more 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 diversity of training required has made it necessary to develop several specialized courses of study, each pertaining to a particular industry within the field of ceramics.

The ceramics training program embraces courses of study applied specifically to the type of industrial work that prevails for a group of students at any particular location. In this system the courses are of

72 hours duration. This type of application presupposes the ability of the student to understand the fundamental chemistry, physics, and mathematics. Where such prerequisite knowledge is lacking, the student will be required to remedy this situation.

CER. 921X. GLASS TECHNOLOGY I: Applications to the glass industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials; pyrometry; fuels and their combustion; and refractories. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 72 hours, 4½ units.

CER. 922X. GLASS TECHNOLOGY II: Melting and forming of all kinds of glass products, and the physical, chemical, and mechanical properties of glasses. Prerequisite: Cer. 921X. Textbook: Scholes, S. R., *Modern Glass Practice*, revised edition, Industrial Publications, Inc., \$6.00. 72 hours, 4½ units.

CER. 923X. WHITEWARES I: Applications to the whitewares industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials; pyrometry; fuels and their combustion; and refractories. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 72 hours, 4½ units.

CER. 924X. WHITEWARES II: Drying and firing whitewares; forming and glazing claywares. Prerequisite: Cer. 923X. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, \$4.00. 72 hours, 4½ units.

CER. 925X. REFRACTORIES I: Applications to the refractories industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials; pyrometry; fuels and their combustion. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 72 hours, 4½ units.

CER. 926X. REFRACTORIES II: Refractories technology and industrial practice. Prerequisite: Cer. 925X. Textbook: Coxey, J. R., *Refractories*, Mineral Industries Extension Services, \$2.50. 72 hours, 4½ units.

CER. 927X. HEAVY CLAY PRODUCTS I: Applications to the heavy clay products industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 72 hours, 4½ units.

CER. 928X. HEAVY CLAY PRODUCTS II: Forming and glazing heavy clay products; pyrometry; fuels and their combustion; and refractories. Prerequisite: Cer. 927X. Textbook: McNamara, E. P., *Ceramics, Volume II*, \$3.50, and McNamara, E. P., *Ceramics, Volume III*, \$4.00, Mineral Industries Extension Services. 72 hours, 4½ units.

Fuel Technology Extension

The proper utilization of mineral fuels is receiving more attention in the industrial world of today than ever before. There is hardly an industry that does not count the use of mineral fuels as one of its major cost items, and proper utilization can mean a saving that will be proportionate to the amount of a particular fuel used. In an attempt to secure better utilization, industry is searching for new ways of burning fuels and is installing newer types of fuel burning equipment. There is a constant and increasing need for trained technicians who can operate or direct the operation of this frequently complicated equipment.

The fuel technology extension program is intended to provide the type of training that operators of fuel burning equipment, supervisors, and technicians need in order to secure the most efficient utilization of fuels. Two credit courses are available, and these are applicable in the fields of metallurgy, ceramics, and power and heating plants. An informal instruction course on the maintenance of instruments used in the control of fuel utilization has been operated for several years at one location; this course is available for application elsewhere upon request.

FUEL T. 901X. BASIC FUELS AND COMBUSTION: An introduction to solid, liquid, and gaseous fuels, including a description of the occurrence, use, analysis, and properties of coal, oil, natural gas, coke, producer gas, water gas, oil gas, etc.; fundamental chemistry related to the combustion process; combustion calculations; material and heat balance. Textbook: Axelsson, F. R., *Fuels and Combustion*, a mimeographed pamphlet, Mineral Industries Extension Services, \$2.00. 72 hours, 4½ units.

FUEL T. 902X. ADVANCED FUELS AND COMBUSTION: Application of fuels, combustion equipment, practical fuel burning problems, and combustion controls. Prerequisite: Fuel T. 901X or equivalent. Textbook: de Lorenzi, Otto, *Combustion Engineering*, Combustion Engineering Company, Incorporated, \$3.50. 72 hours, 4½ units.

Metallurgy Extension

Pennsylvania is the leading producer of iron and steel in the nation. Also, in spite of its relatively small production of nonferrous ores,

it is a leader in the nonferrous field, due mainly to the availability of skilled labor, ready markets, and superior fuels. In view of the importance of the metallurgical industries to the economy of the State, it is logical that training programs designed especially for the employees of this great industry should be provided through the extension services of the School.

Four courses of study have been developed in the ferrous metallurgy field, with two options available. The first course is preparatory and covers the necessary basic sciences; the second deals with process metallurgy; the third covers physical ferrous metallurgy; and the fourth is a laboratory course in ferrous metallurgy.

The first option for students would be a program composed of the first, second, and third courses; this may be considered as proper coverage for a fully integrated metallurgical plant. The second option would include the first, third, and fourth courses; this would be the proper coverage for the semi-integrated or fabricating plant. There is no restriction on adding the missing course to either option if the class so desires. Diplomas are granted for completion of either option; certificates are granted for completion of the additional course.

A recent development in the ferrous metallurgy field is the terminal type of course designed for a specific application. Experimental courses in "open hearth practice" and "steel foundry practice" have been operated as informal instruction programs. As more experience is gained and the courses become standardized, they will be added to the list of "approved" courses. Still other types of terminal courses are contemplated to meet the needs of the industry.

The nonferrous metallurgy industry has made no urgent demand for training, largely because of the widely scattered nature of the industry and the generally small size of individual plants. There is, however, a need for training within the industry, and one course, *Introductory Physical Metallurgy*, has been designed for such application. As interest in such training develops, additional courses will be devised to meet the training needs.

Prerequisites for entering a metallurgy extension class will depend on the particular course offered. The preparatory course of the ferrous metallurgy options is considered to require training in high school chemistry and physics for entrance, but lack of this training does not prevent a student from entering the class; it merely means that more intensive study of the fundamentals provided in the course will be necessary. Advanced courses in each option usually have the preceding course or its equivalent as a prerequisite. Terminal courses are usually offered without a stated prerequisite.

MET. 901X. INTRODUCTION TO FERROUS METALLURGY: Certain fundamentals of chemistry and physics; pyrometry; metallurgical fuels and their combustion; fluxes, slags and refractories; theory and operation of the iron blast furnace and the production of pig iron; principles of iron founding, malleable cast iron, and production of wrought iron. Textbook: Teichert, E. J., *Ferrous Metallurgy, Volume I*, 2nd ed., McGraw-Hill Book Co., Inc., \$5.00. 144 hours, 9 units.

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*, 2nd ed., McGraw-Hill Book Co., Inc., \$5.00. 144 hours, 9 units.

MET. 903X. PHYSICAL FERROUS METALLURGY: Laboratory technique; non-destructive testing; physical testing; constitution of alloys; the iron-carbon diagram; the metallography 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*, 2nd ed., McGraw-Hill Book Co., Inc., \$6.00. 144 hours, 9 units.

MET. 904X. PHYSICAL METALLURGY LABORATORY: Laboratory technique and the use of laboratory equipment; calibration of base metal thermocouples; macro-examination of steel; microscopic examination of steel; effects of (a) carbon content, (b) cold work, and (c) various heat treatments on the structure and properties of plain carbon steel; heat treatment and micro-examination of alloy steels; a study of the modern concept of hardenability testing. Prerequisite: Met. 903X. 144 hours, 9 units.

MET. 905X. INTRODUCTORY PHYSICAL METALLURGY: Structure and properties of commercially pure metals; effect of cold work and annealing constitution of binary alloys; structure and properties of certain commercially important alloys; constitution, theory of heat treatment, and alloying elements in steels; application to engineering use of alloys, steels, and cast irons; powder metallurgy. Prerequisite: graduation from a four-year high school course, including chemistry and physics. Textbook: Brick, R. M., and Phillips, Arthur, *Structure and Properties of Alloys*, 2nd ed., McGraw-Hill Book Co., Inc., \$6.00. 144 hours, 9 units.

Supervisory Extension Training

Modern industrial practices in the mineral industries field place a tremendous responsibility on the supervisor. He is usually held accountable for the quantity and quality of production, the health and safety of the men, the planning of the work, and the maintenance of good morale. Where the work involves use of machinery, he is expected to have some knowledge of its operation and maintenance. And frequently he must be well versed in the technology of the processes under his control in order to secure the quality of product desired.

It is rare when an individual possesses all of these qualifications naturally; yet each supervisor must have all of these abilities to some degree in order to properly discharge his supervisory duties. Many companies have developed training programs for their supervisors in order to overcome deficiencies in their work, and the Supervisory Extension Training program of Mineral Industries Extension Services has been designed either to assist those companies with well-developed training programs or to aid companies in organizing such training work. The value of the assistance provided lies in the use of persons who are specialists in that particular mineral industry to develop and supervise the program for a particular plant or company. Many of the supervisory problems that arise today are technologic in nature, and their solution demands an investigation under the guidance of a person trained in the technology of the industry.

The development of a training program that will be applicable to all of the individuals who are supervisors in a mine, plant, or mill must be extremely flexible because the problems encountered by various groups of supervisors are quite different. The Supervisory Extension Training program provides this flexibility by utilizing the "conference" method of problem discussion. The length of program developed for a particular company will depend on the number of supervisory phases to be included, and these are discussed in advance with an advisory group from the management of that company who also follow the progress of the program as it develops. Provisions have been made whereby groups that recognize their deficiency in a particular technical subject are given an opportunity to take classroom instruction in that subject. The supervisory conference sessions are normally held once each week, with each session lasting between one and one and one half hours. Supervisory personnel included in each program are usually grouped according to rank, although in small company organizations it is sometimes necessary to cut across ranks in selecting persons to be given the training. Groups are normally held to between 12 and 15 persons; and where a large number of supervisory

personnel are to be given training, the number of groups will be found by dividing the total number of persons by this average group size.

The planning of each company program and the conduct of the conference sessions are under the direction of staff members of Mineral Industries Extension Services. The greatest development of this training service has been in the mining industry, but programs have also been conducted in the ceramics and metallurgical industries. At present each specific program is limited to the employees of the sponsoring company, which also bears the expense of operation. Later, it is hoped, area programs will be developed so that supervisory employees from a number of companies may attend. Supervisory Extension Training constitutes "informal instruction" for which no credits are granted, although recognition certificates are issued to each person in attendance.

Mineral Industries Correspondence Instruction

Correspondence instruction is an important part of the extension service of the School of Mineral Industries. Both college-credit and industrial type courses are offered by correspondence, and in most instances such courses are not available through any other college or university correspondence division in the country. The college-credit courses are duplicates of those offered in resident instruction on the campus, and in many instances the same instructors are used to correct the correspondence lessons, insuring the same quality of instruction available to students in residence. Industrial type courses likewise are duplicates of courses offered in extension, and the persons who supervise the extension programs are the instructors who correct the correspondence lessons. Every effort is made to maintain the correspondence instruction work at a high level of quality. New courses will be offered when requests, backed by sufficient evidence of interest, to develop such courses are received.

GROUPS FOR WHOM COURSES ARE INTENDED

The correspondence courses described in this circular 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.

(2) Regular college students compelled temporarily to discontinue resident study, or desirous of completing courses during vacation periods.

(3) Persons who want to keep abreast of the times and prepare for advancement in their special fields of interest.

(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.

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.

COLLEGE-CREDIT COURSES

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

All questions concerning credit for subjects studied elsewhere must also be directed to the Dean of Admissions.

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 Dean of Admissions is officially notified when a student successfully completes a college credit subject.

A grade report is issued from the Office of Admissions and Registrar to each student upon the successful completion of a college-credit correspondence course. Official transcript of a student's Correspondence Study record will be mailed by the Registrar of the College upon payment of a 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 baccalaureate 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.

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 course is listed with the course description. This fee amounts to \$9.00 per college credit and \$3.00 per unit of industrial credit. The total fee covers the cost of the lesson instructions, the postage paid by the College in sending materials and returning corrected lessons, and the instructional service charge. An additional postage fee of \$1.00 per course is charged to students with residences outside the United States.

TEXTBOOKS AND COURSE MATERIALS

The textbook and any other materials required for the course are listed with the course description, and these are obtained through Mineral Industries Extension Services. Payment for books and other required materials should be made at the same time as payment of the fee is made. Where the listed textbook and other materials are available to the student, it will not be necessary to purchase them through the College.

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 75 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 total number of 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. Reinstatement for a period of six months will be made upon payment of a fee of \$1.00. There shall be no extension of time beyond this initial period. However, 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 specified, 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 upon payment of 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 secured by the student. 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

A Mineral Industries Extension Services Certificate is awarded upon successful completion of a subject course carrying "unit" credits.

A Mineral Industries Extension Services Diploma is awarded upon the successful completion of a series of related subjects carrying "unit" credits offered as a curriculum by the Extension Services.

Credits earned either by class or correspondence study are applicable toward a Mineral Industries Extension Services diploma.

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.

Other Correspondence Courses Offered by the College

CORRESPONDENCE COURSES IN AGRICULTURE AND HOME ECONOMICS

J. L. E. McCord, In Charge of Correspondence Courses in Agriculture,
The Pennsylvania State College, State College, Pennsylvania.

CORRESPONDENCE COURSES IN THE LIBERAL ARTS, CHEMISTRY AND PHYSICS, ENGINEERING, HEALTH AND PHYSICAL EDUCATION

William R. Young, Supervisor of Correspondence Instruction, Central Ex-
tension, The Pennsylvania State College, State College, Pennsylvania.

CORRESPONDENCE COURSES IN EDUCATION AND PSYCHOLOGY

Joseph J. Lowden, Director of Education Extension, The Pennsylvania
State College, State College, Pennsylvania.

CORRESPONDENCE COURSES IN INDUSTRIAL EDUCATION AND INDUSTRIAL ARTS EDUCATION

S. Lewis Land, Head of Department of Industrial Education, The Penn-
sylvania State College, State College, Pennsylvania.

CORRESPONDENCE COURSES OFFERED THROUGH THE UNITED STATES ARMED FORCES INSTITUTE

Correspondence courses in mineral industries subjects appearing
in this circular are available to personnel of the United States Armed
Forces under the contract between the College and the U.S.A.F.I. Many
of these courses carry college credit; others are of less than college grade,
available as refresher subjects in some instances, or as retraining in
others. The educational officer of each post should be consulted regarding
enrollment and processing of the application.

Correspondence Courses in Mineral Industries

Earth Sciences

GEOGRAPHY

GEOG. 20C. WORLD GEOGRAPHY: A brief systematic regional description
of the earth's surface, including both man-made and natural features,
together with explanation of these features. Textbook: Whitebeck, R. H.,
and Finch, V. C., *Economic Geography*, 4th ed., McGraw-Hill Book Com-
pany, Inc., \$4.75. 24 assignments. Fee \$27; 3 college credits.

GEOG. 24C. ELEMENTS OF GEOGRAPHY: General survey of the character-
istics of the major types of land surfaces, climates, soils, and resources
that comprise the natural environment of man. Textbook: Finch, V. E.,
and Trewartha, G. T., *Elements of Geography*, 2nd ed., McGraw-Hill Book
Company, Inc., \$6.00. 24 assignments. Fee \$27; 3 college credits.

GEOG. 26C. ECONOMIC GEOGRAPHY: The geography of the world's com-
modities and their regional aspects; land uses, extractive and manufactur-
ing industries and their natural and cultural relationships. Textbook:
Jones, C. F., and Darkenwald, G. G., *Economic Geography*, 1st ed., The
Macmillan Company, \$5.50. 24 assignments. Fee \$27; 3 college credits.

GEOG. 30C. GEOGRAPHY OF NORTH AMERICA: A systematic geographic
study of land forms, climates, vegetation, soils, agriculture, lumbering,
mining, manufacturing, transportation, and trade of the United States,
Canada, and Alaska. Textbook: Smith, J. Russel, and Phillips, M. Ogden,
North America, 1st ed., Harcourt, Brace and Co., Inc., \$6.00. Set of 12
maps, No. DD5, A. J. Nystrom Co., Chicago, Ill., \$0.48. 24 assignments.
Fee \$27; 3 college credits.

GEOG. 32C. GEOGRAPHY OF PENNSYLVANIA: The regional geography of
the State as to topography, climate, soils, minerals, agriculture, industry,
and commerce. Textbook: Murphy, Raymond E., and Murphy, Marion,
Pennsylvania: A Regional Geography, Penns Valley Publishers, Inc.,
\$5.00. Set of 20 letter size outline maps of Pennsylvania, Rand McNally
Co., \$0.25. 24 assignments. Fee \$27; 3 college credits.

GEOG. 460C. POLITICAL GEOGRAPHY: Geographical foundations of political phenomena; significant geographic factors in growth and development of states, boundary problems, population distribution, colonies, and internal and international regional problems. Prerequisite: 6 credits in geography, history, or political science. Textbook: Pearcey, Etzel, Fifield, P., and Associates, *World Political Geography*, 1st ed., The Thomas Y. Crowell Co., \$5.00. 24 assignments. Fee \$27; 3 college credits.

GEOLOGY

GEOLOG. 30C. PHYSICAL AND HISTORICAL GEOLOGY: Combines the fields of Geol. 31 and 32. Practicum includes map work, and the study of important rocks and fossils. Textbook: Longwell, C. R., Knopf, Flint, Schuchert, C., and Dunbar, C. O., *Outlines of Geology*, 2nd ed., John Wiley and Sons, Inc., \$5.75. Set of 15 topographic maps, \$3.00. 24 assignments. Fee \$27; 3 college credits.

GEOLOG. 31C. PHYSICAL GEOLOGY: Earth forces, and their effects on the materials, structure, and physiography of the earth's crust. Practicum includes study of rocks, minerals, and topographic maps. Textbook: Longwell, Knopf, and Flint, *Physical Geology*, 3rd ed., John Wiley and Sons, Inc., \$5.75. Tray of minerals: Ward's Natural Science Establishment, set No. MC50, \$8.75. Set of 22 topographic maps, \$4.40. 24 assignments. Fee \$27; 3 college credits.

GEOLOG. 32C. HISTORICAL GEOLOGY: The history of the earth and its life. Practicum includes a study of geologic maps and fossil specimens concerned with the geology of Pennsylvania. Prerequisite: Geol. 31C. Textbook: Dunbar, C. O., *Historical Geology*, John Wiley and Sons, Inc., \$5.75. Set of outline maps, \$0.50. Set of geologic maps and folios, \$4.00. 24 assignments. Fee \$27; 3 college credits.

GEOLOG. 451C. ECONOMIC GEOLOGY: An introduction to the study of mineral deposits. Prerequisites: Geol. 32C, Min. 31 or 53. Textbook: Bateman, A. M., *Economic Mineral Deposits*, 1st ed., John Wiley and Sons, Inc., \$7.50. 24 assignments. Fee \$27; 3 college credits.

GEOLOG. 461C. GEOLOGY OF THE UNITED STATES: Stratigraphy, geologic structure, and geomorphology of the United States. Prerequisite: Geol. 32C. Textbook: Fenneman, N. M., *Physiography of the Western United States*, \$6.00, and *Physiography of the Eastern United States*, \$7.50, McGraw-Hill Book Co., Inc. Set of geologic, physiographic, and topographic maps, \$8.00. 24 assignments. Fee \$27; 3 college credits.

GEOPHYSICS

GEOPHYS. 304C. GEOPHYSICAL PROSPECTING FOR OIL: The theory, practice, and interpretation of seismic, gravitational, magnetic, electrical, geothermal and radioactive measurements, made over the ground or in bore holes, in the search for commercial accumulations of oil and gas. Prerequisites: Geol. 31C; Phys. 285. Textbook: Nettleton, L. L., *Geophysical Prospecting for Oil*, 1st ed., McGraw-Hill Book Co., Inc., \$6.00. 24 assignments. Fee \$27; 3 college credits.

METEOROLOGY

METEOR. 300C. WEATHER AND MAN: Nontechnical treatment of fundamentals of modern meteorology; effect of weather and climate on man and his activities. Textbook: Neuberger, H., and Stephens, F. B., *Weather and Man*, 1st ed., Prentice-Hall, Inc., \$3.75. 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*, 1st ed., McGraw-Hill Book Co., Inc., \$7.00. 24 assignments. Fee \$27; 3 college credits.

METEOR. 315C. SYNOPTIC METEOROLOGY EXERCISES I: Practice in surface and upper air weather codes and charts; elementary map analysis and weather forecasting. Prerequisite: Meteor. 310C. Textbook: Pulk and Murphy, *Workbook in Weather Forecasting*, 1st ed., Prentice-Hall, Inc., \$3.75. 24 assignments. Fee \$27; 3 college credits.

METEOR. 316C. SYNOPTIC METEOROLOGY EXERCISES II: Analysis of and practice weather forecasting from preplotted weather data representing typical weather situations. Prerequisite: Meteor. 315C. Textbook: none. Set of preplotted charts, \$12.00. 24 assignments. Fee \$27; 3 college credits.

METEOR. 317C. SYNOPTIC METEOROLOGY EXERCISES III: Continuation of Meteor. 316C involving more complicated weather situations. Prerequisite: Meteor. 316C. Textbook: none. Set of preplotted charts, \$12.00. 24 assignments. Fee \$27; 3 college credits.

METEOR. 340C. PHYSICAL METEOROLOGY: Physical processes of radiation and condensation; theoretical and practical aspects of visibility; propagation of sound in the atmosphere; facts and theories pertaining to atmospheric optics and electricity. Prerequisite: Meteor. 310C. Textbook: Neuberger, H., *Introduction to Physical Meteorology*, 1st ed., Mineral Industries Extension Services, \$3.50. 24 assignments.

Fee \$27; 3 college credits.

METEOR. 350C. DYNAMIC METEOROLOGY: Atmospheric statics and thermodynamics; equations of motion; kinematic analysis of the pressure field; circulation and vorticity; theory of perturbation and circulation. Prerequisite: Math. 431. Meteor. 310C. Textbook: Haurwitz, B., *Dynamic Meteorology*, 1st ed., McGraw-Hill Book Co., Inc., \$5.50. 24 assignments.

Fee \$27; 3 college credits.

METEOR. 360C. METEOROLOGICAL INSTRUMENTS AND OBSERVATIONS: Principles underlying instruments used for meteorological measurements, and their limitations, with particular emphasis upon the importance of proper handling, exposure, and maintenance of instruments. Prerequisite: Phys. 265. Textbook: Haynes, B. C., *Techniques of Observing the Weather*, 1st ed., John Wiley and Sons, Inc., \$4.00. Set of supplementary notes, \$1.00. 24 assignments.

Fee \$27; 3 college credits.

METEOR. 372C. PHYSICAL CLIMATOLOGY: Collection and use of climatological data; physical aspects and composition of climatic elements; applied climatology. Prerequisite: Phys. 215. Textbook: Landsberg, Helmut, *Physical Climatology*, Gray Printing Co., \$3.50. 24 assignments.

Fee \$27; 3 college credits.

METEOR. 373C. DYNAMIC CLIMATOLOGY: Physical principles underlying the variations in climate; climatic controls; elements of microclimatology; interpretation of selected regional climates in terms of the dynamics of the atmosphere. Prerequisite: Meteor. 310C. Textbook: Haurwitz, B. and Austin, J. M., *Climatology*, 1st ed., McGraw-Hill Book Co., Inc., \$6.00. 24 assignments.

Fee \$27; 3 college credits.

METEOR. 900C. A PRACTICAL COURSE IN WEATHER: A nontechnical treatment of the elements of meteorology. The composition of the atmosphere and its physical properties, thunderstorms, winds and turbulence, the polar-front theory of cyclones, highs and lows, tropical cyclones, icing on aircraft, forecasting from synoptic charts. Textbook: Brands, G. J., *Meteorology, A Practical Course in Weather*, 1st ed., McGraw-Hill Book Co., Inc., \$4.00. 8 assignments.

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: Caudle, F. L., *Workbook in Elementary Meteorology*, 1st ed., McGraw-Hill Book Co., Inc., \$1.80. 8 assignments.

Fee \$9; 3 units.

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*, 3rd ed., John Wiley and Sons, Inc., \$3.90. Tray of minerals: Ward's Natural Science Establishment, \$10.25. 15 assignments.

Fee \$18; 2 college credits.

Mineral Engineering

MINERAL ECONOMICS

MIN. ECON. 1C. ELEMENTS OF MINERAL ECONOMICS: The occurrence and distribution of the mineral resources of the world and relationships to the industrial and economic development of society. Textbook: Lovering, T. S., *Minerals in World Affairs*, 1st ed., Prentice-Hall, Inc., \$4.00. 24 assignments.

Fee \$27; 3 college credits.

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. Includes basic studies in mathematics, geology, coal resources, mining physics, mining chemistry, mine gases, detection of gases, and elementary mine ventilation. Students in Pennsylvania are provided studies in the mining laws of Pennsylvania as related material. This course prepares for the fire boss certificate examination. Textbooks: Jones, D. C., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C., and Hunt, J. W., *Coal Mining, Volume I*, 3rd ed., \$4.00. Mineral Industries Extension Services. *Mining Laws of Pennsylvania*. 24 assignments.

Fee \$27; 9 units.

MNG. 902C. INTERMEDIATE COAL MINING: Includes basic studies in mathematics, advanced mine ventilation, combustion and oxidation, mine fires, mine explosions, rock dusting, mine rescue and recovery work, explosives and blasting, mine timbering methods, mine drainage, and compressed

air. This course prepares for the mine foreman certificate examination. Prerequisite: Mng. 901C. Textbooks: Jones, D. C., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Hunt, J. W., *Coal Mining, Volume II*, 3rd ed., \$4.00, Mineral Industries Extension Services. 24 assignments.

Fee \$27; 9 units.

MNG. 903C. ADVANCED COAL MINING: Includes expression aids for the supervisor, mining methods (anthracite and bituminous), equipment, ventilation practices, underground transportation, and electricity. 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. 902C. Textbooks: Jones, D. C., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Hunt, J. W., *Coal Mining, Volume III*, 3rd ed., \$4.50, Mineral Industries Extension Services.

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., *Mining Mathematics*, 2nd ed., \$1.75, and Jones, D. C. and Altimus, M. E., *Mechanized Mining Electrical Applications*, 2nd ed., \$4.50, Mineral Industries Extension Services. *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 is desirable. Textbook: Stephens, M. M. and Spencer, O. F., *Petroleum and Natural Gas Engineering, Volume I*, 2nd ed., Mineral Industries Extension Services, \$1.00. 24 assignments.

Fee \$27; 9 units.

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, introduction to secondary recovery, fundamental geology, petroleum mineralogy, lease and leasing, and chemical and physical properties of petroleum and natural gas. Pre-

requisite: Pet. F. 901C. Textbook: Stephens, M. M. and Spencer, O. F., *Petroleum and Natural Gas Production*, 2nd ed., Mineral Industries Extension Services, \$1.50. 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 four sections. The first includes natural gas economics, measuring properties of natural gas, and gas well completion. The second includes gas gathering, compression, and transmission. The third includes gas measurement and regulation. The fourth includes natural gasoline manufacturing and cycling, and stabilizers and stabilization. Prerequisite: Pet. E. 902C. Textbook: Stephens, M. M. and Spencer, O. F., *Natural Gas Engineering*, 2nd ed., Mineral Industries Extension Services, \$4.50. 24 assignments.

Fee \$27; 9 units.

PETROLEUM REFINING ENGINEERING

PET. E. 904C. 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*, 2nd ed., Mineral Industries Extension Services, \$4.00. 24 assignments.

Fee \$27; 9 units.

PET. E. 905C. UNIT PROCESSING: Includes organic chemistry, crude oil evaluation, petroleum refining equipment, refining by distillation, natural gasoline manufacture, stabilizers and stabilization, thermal cracking, alkylation and polymerization, catalytic refining, refining by use of chemicals, adsorption, crystallization, lubricating oil additives and blending, lubricating grease manufacture, refinery control laboratory, and storage of gasoline and oil. Prerequisite: Pet. E. 904C. Textbook: Stephens, M. M. and Spencer, O. F., *Petroleum Refining, Volume II*, 2nd ed., Mineral Industries Extension Services, \$4.50. 24 assignments.

Fee \$27; 9 units.

PET. E. 906C. PETROLEUM REFINING ENGINEERING: Covers refinery products and test methods, evaluation of oil stocks, physical properties of petroleum oils, fluid mechanics, combustion, vaporization and condensation, fractionation and towers, heat transfer and exchangers, tube-still heaters, economics of design, and typical design calculations. Prerequisite: Pet. E. 905C. Textbook: Nelson, W. L., *Petroleum Refinery Engineering*, 3rd ed., McGraw-Hill Book Co., Inc., \$9.00. 24 assignments.

Fee \$27; 9 units.

PETROLEUM PRODUCTION ENGINEERING

PET. E. 907C. PETROLEUM PRODUCTION ENGINEERING FUNDAMENTALS: Petroleum production engineering fundamentals with problems applying specifically to this field, including mathematics, physics, and inorganic chemistry. 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*, 2nd ed., Mineral Industries Extension Services, \$4.00. 14 assignments. Fee \$15; 5 units.

PET. E. 908C. PETROLEUM PRODUCTION TECHNOLOGY: Petroleum mineralogy, formation, classification and properties of sedimentary rocks, origin and migration of petroleum and natural gas, structural geology, exploration for petroleum and natural gas, drilling practices, well testing and completion, reservoir efficiency and well spacing, and introduction to secondary recovery. Prerequisite: Pet. E. 907C. Textbook: Stephens, M. M. and Spencer, O. F., *Petroleum and Natural Gas Production*, 2nd ed., Mineral Industries Extension Services, \$4.50. 14 assignments. Fee \$15; 5 units.

PET. E. 909C. SECONDARY RECOVERY OF OIL: Covers secondary recovery of oil by water flooding and injected gas drive. Topics include geological factors, reservoir susceptibility, well spacing and flood pattern, water source and purification, design and operation of plants, correcting a heterogeneous permeability profile, reconditioning wells, estimating costs. Prerequisite: Pet. E. 908C. Textbook: Spencer, O. F., *Secondary Recovery of Oil*, Mineral Industries Extension Services, \$4.50. 14 assignments.

Fee \$15; 5 units.

Mineral Technology

CERAMICS

With the exception of two courses (Cer. 914C and Cer. 919C) the work offered by Correspondence Instruction parallels that offered in extension through classroom instruction.

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, fire clay products, and whitewares. Prerequisite: any one of the following: Cer. 922C, 924C, 926C, 928C. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, \$4.00. 18 assignments.

Fee \$20.25; 7 units.

CER. 919C. ENAMELS: The preparation and properties of enamels and their application to metal surfaces. Textbook: Andrews, A. I., *Enamels*, Twin City Publishing Company, \$5.50. 24 assignments. Fee \$27; 9 units.

CER. 921C. GLASS TECHNOLOGY I: Applications to the glass industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials; pyrometry; fuels and their combustion; and refractories. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 12 assignments. Fee \$13.50; 4½ units.

CER. 922C. GLASS TECHNOLOGY II: Melting and forming of all kinds of glass products, and the physical, chemical, and mechanical properties of glasses. Prerequisite: Cer. 921C. Textbook: Scholes, S. R., *Modern Glass Practice*, revised edition, Industrial Publications, Inc., \$6.00. 12 assignments. Fee \$13.50; 4½ units.

CER. 923C. WHITEWARES I: Applications to the whitewares industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials; pyrometry; fuels and their combustion; and refractories. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 12 assignments. Fee \$13.50; 4½ units.

CER. 924C. WHITEWARES II: Drying and firing whitewares; forming and glazing claywares. Prerequisite: Cer. 923C. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, \$4.00. 12 assignments. Fee \$13.50; 4½ units.

CER. 925C. REFRACTORIES I: Applications to the refractories industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials; pyrometry; and fuels and their combustion. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 12 assignments. Fee \$13.50; 4½ units.

CER. 926C. REFRACTORIES II: Refractories technology and industrial practice. Prerequisite: Cer. 925C. Textbook: Coxey, J. R., *Refractories*, Mineral Industries Extension Services, \$2.50. 12 assignments. Fee \$13.50; 4½ units.

CER. 927C. HEAVY CLAY PRODUCTS I: Applications to the heavy clay products industry of the occurrence, uses, properties, and beneficiation of ceramic raw materials. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, \$3.50. 12 assignments. Fee \$13.50; 4½ units.

CER. 928C. HEAVY CLAY PRODUCTS II: Forming and glazing heavy clay products; pyrometry; fuels and their combustion; and refractories. Prerequisite: Cer. 927C. Textbooks: McNamara, E. P., *Ceramics, Volume II*, \$3.50, and McNamara, E. P., *Ceramics, Volume III*, \$4.00, Mineral Industries Extension Services. 12 assignments. Fee \$13.50; 4½ units.

FUEL TECHNOLOGY

FUEL T. 901C. BASIC FUELS AND COMBUSTION: An introduction to solid, liquid, and gaseous fuels, including a description of the occurrence, use, analysis, and properties of coal, oil, natural gas, coke, producer gas, water gas, oil gas etc.; fundamental chemistry related to the combustion process; combustion calculations; material and heat balance. Textbook: Axelson, F. R., *Fuels and Combustion*, a mimeographed pamphlet, Mineral Industries Extension Services, \$2.00. 12 assignments.

Fee \$13.50; 4½ units.

FUEL T. 902C. ADVANCED FUELS AND COMBUSTION: Application of fuels, combustion equipment, practical fuel burning problems, and combustion controls. Prerequisite: Fuel T. 901C or equivalent. Textbook: de Lorenzi, Otto, *Combustion Engineering*, Combustion Engineering Company, Incorporated, \$3.50. 12 assignments. Fee \$13.50; 4½ units.

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 furnace; principles of iron founding; production of wrought iron; Bessemer, open hearth, electric furnace, and special processes of steel makings; the steel ingot; rolling mill practice; the manufacture of steel strip, sheet, tin plate, wire, tubular products, and structural shapes; general welding methods; forging practice; the steel foundry. Textbook: Teichert, E. J., *Ferrous Metallurgy, Volumes I and II*, 2nd ed., McGraw-Hill Book Co., Inc., \$5.00 each. 24 assignments. Fee \$27; 9 units.

MET. 903C. 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 speci-

fication 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 including chemistry and physics. Textbook: Teichert, E. J., *Ferrous Metallurgy, Volume III*, 2nd ed., McGraw-Hill Book Co., Inc., \$6.00. 24 assignments. Fee \$27; 9 units.

MET. 905C. INTRODUCTORY PHYSICAL METALLURGY: Structure and properties of commercially pure metals; effect of cold work and annealing; constitution of binary alloys; structure and properties of certain commercially important alloys; theory of heat treatment and alloying elements in steels; application to engineering use of alloys, steels, and cast irons; powder metallurgy. Prerequisite: graduation from a four-year high school course, including chemistry and physics. Textbook: Brick, R. M., and Phillips, Arthur, *Structure and Properties of Alloys*, 2nd ed., McGraw-Hill Book Co., Inc., \$6.50. 24 assignments. Fee \$27; 9 units.

MET. 920C. THE CONTROL OF MODERN STEEL FOUNDRY OPERATIONS: Melting processes used in steel foundries; methods of controlling gas in liquid steel and the resultant castings; fundamentals of a sand control program; proper use of binders and mold washes; prevention of hot tear defects in steel castings; effects of contraction; sand reclamation; cleaning of castings; nondestructive inspection of castings; repair welding. It is suggested that Met. 903C be taken on completion of this course to benefit the student interested in the heat treatment and physical metallurgy of steel castings. Textbook: Briggs, C. W., *The Metallurgy of Steel Castings*, McGraw-Hill Book Co., Inc., \$7.00. 24 assignments. Fee \$27; 9 units.

Textbooks and Their Costs

Mineral Industries Extension Services textbooks are prepared and published primarily for use by students in extension classes in Pennsylvania or for correspondence instruction. The books are revised as frequently as is necessary to include discussions of the most modern industrial practices; thus, revision may be made every two or three years in some cases, every five years or longer in other cases. Limited quantities are published, and the listed prices are not subject to discount, either for cash or for quantity shipments.

Persons desiring copies may obtain them by addressing MINERAL INDUSTRIES EXTENSION SERVICES, Mineral Sciences Building, State College, Pennsylvania. Domestic mail orders are shipped without additional charge; foreign mail orders require the payment of 25 cents per volume in addition to the listed price. All orders must be accompanied by payment, either by check or money order. Books will not be forwarded C.O.D. In making remittance on book orders, all checks or money orders should be made payable to THE PENNSYLVANIA STATE COLLEGE and sent to Mineral Industries Extension Services.

<i>Ceramics</i> , Volume I.....	\$3.50
<i>Ceramics</i> , Volume II.....	3.50
<i>Ceramics</i> , Volume III.....	4.00
<i>Refractories</i>	2.50
<i>Coal Mining</i> , Volume I, 3rd ed.....	4.00
<i>Coal Mining</i> , Volume II, 3rd ed.....	4.00
<i>Coal Mining</i> , Volume III, 3rd ed.....	4.50
<i>Mining Mathematics</i> , 2nd ed.....	1.75
<i>Mechanized Mining Electrical Applications</i> , 2nd ed....	4.50
<i>Petroleum and Natural Gas Engineering</i> , Volume I, 2nd ed.....	4.00
<i>Petroleum and Natural Gas Production</i> , 2nd ed.....	4.50
<i>Natural Gas Engineering</i> , 2nd ed.....	4.50
<i>Petroleum Refining</i> , Volume II, 2nd ed.....	4.50
<i>Petroleum Refining</i> , Volume III.....	3.50
<i>Secondary Recovery of Oil</i>	4.50
<i>Mineral Industries Education</i>	3.00
<i>Introduction to Physical Meteorology</i>	3.50

Other Mineral Industries Extension Services textbooks, available either through the Extension Services at the listed prices or through the publisher, are as follows:

Ferrous Metallurgy, Volume I, 2nd ed., Teichert, E. J., McGraw-Hill Book Company, Inc., \$5.00.

Ferrous Metallurgy, Volume II, 2nd ed., Teichert, E. J., McGraw-Hill Book Company, Inc., \$5.00.

Ferrous Metallurgy, Volume III, 2nd ed., Teichert, E. J., McGraw-Hill Book Company, Inc., \$6.00.

Addresses of Publishers of Textbooks Listed in Course Descriptions

Combustion Engineering Co.,

200 Madison Avenue, New York 16, N. Y.

Thomas Y. Crowell Co., 432 Fourth Avenue, New York 16, N. Y.

D. Appleton-Century-Crofts, West 32nd Street, New York, N. Y.

Ginn and Company, 70 Fifth Avenue, New York, N. Y.

Gray Printing Company, Falls Creek, Pa.

Harcourt, Brace and Co., Inc.,

383 Madison Avenue, New York, N. Y.

Industrial Publications Inc.,

5 South Wabash Avenue, Chicago 3, Ill.

Macmillan Company, 60 Fifth Avenue, New York, N. Y.

McGraw-Hill Book Co., Inc.

330 West 42nd Street, New York, N. Y.

Mineral Industries Extension Services, State College, Pa.

Penns Valley Publishers, Inc.,

121 South Frazier St., State College, Pa.

Prentice-Hall, Inc., New York, N. Y.

Twin City Publishing Co., Champaign, Ill.

John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y.