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

GEOENGINEERING

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

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


DIVISIONS OF SERVICE

Resident Instruction
Extension Instruction
Correspondence Instruction
Mineral Industries Research

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STATE COLLEGE, PENNSYLVANIA
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 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 curriculums 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 Curriculums:
- 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
- Welding 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
- Welding Metallurgy

Data:

pertaining to the administration of the work.
Foreword

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 have 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 carried 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 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 1908 to 1915 extension classes in coal mining were conducted by members 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 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 12 years.

In 1931 the extension activities of the School were placed on an organized basis compatible with the unified program of the newly reorganized School of 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 curriculums; (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 curriculums 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...
originally 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 instructions 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. Direction of the work in particular subject-matter fields is assigned to certain staff members who are responsible for (a) organization of extension classes, (b) supervision of class instruction and operation, (c) development of text material suitable for class use, and (d) conducting the correspondence program which parallels the extension class work. In all of this work the designated staff member may be assisted by one or more assistants, depending on the extent of the program. The necessity for knowing the educational needs of the workers in the various mineral industries requires every staff member to make frequent contacts with industrial and educational leaders. Keeping abreast of the most recent industrial developments requires not only frequent visits to the mines, mills, or plants but also attendance at industrial institutes and other educational meetings. Every staff member has had industrial experience in his subject-matter field, and staff members of the mining extension group are certified by the State of Pennsylvania to serve as underground mine officials.

The scope of the extension training conducted throughout Pennsylvania in the field of the mineral industries prior to 1931 cannot be ascertained due to lack of records. In the period from 1931 to 1952, there were 61,443 registrants in mineral industries extension classes held in all areas of the State, and during the same period there were 3050 registrants in mineral industries 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 registrants in Mineral Industries Extension Services courses, during the 1931-52 period is, therefore, (a) regular extension and correspondence instruction—64,493, (b) defense and war training—7138, or a grand total of 71,631, and an average over the 21-year period of 3411 registrants annually. Surveys indicate that students from between 500 and 570 communities in 41 of the 67 counties in the Commonwealth attend 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, Director Emeritus

Mineral Technology
Louis F. Haller,
Assistant Professor*
Irving Dulberg,
Instructor
Virgil P. Quirk,
Instructor
Frederick R. Axelton†
Instructor
Petroleum & Natural Gas
Oscar F. Spencer,
Associate Professor*

Mineral Technology
Louis F. Haller,
Assistant Professor*
Irving Dulberg,
Instructor
Virgil P. Quirk,
Instructor
Frederick R. Axelton†
Instructor
Petroleum & Natural Gas
Oscar F. Spencer,
Associate Professor*

Mining
Joseph W. Hunt,
Associate Professor*
Myles E. Altimus, Jr.,
Assistant Professor
Joseph L. Walker, Jr.,
Instructor

Supervisory Training
Robert B. Hewes,
Associate Professor*
Michael Zulkoski
Instructor

*In Charge.
†On leave of absence—in armed services.

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 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. For students residing in the school district sponsoring the class, there is no tuition charge. Students from other districts, however, must have prior approval by their district school officials before they can enter a class, and on the basis of this approval each district will be invoiced for their proportionate share of the class expense by the sponsoring district. The determination of this proportionate expense is outlined in the school code for Pennsylvania. Nothing in the code prohibits the payment of this tuition charge for an extension student by a nonresident pupil sponsoring agency or employer.

All students are required to purchase their own text material 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 though 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, CURRICULUMS, 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 curriculums 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 are 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 curriculums.

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
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:


Lecture 3 hours per session, 16 sessions. Fee $30; 3 college credits.

**CER. 413. CERAMIC PETROGRAPHY:** Petrographic microscopy and related analytical techniques applied to 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: Geology, coal resources, gases and their detection, elementary ventilation; related mathematics, chemistry, and physics. 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: Advanced ventilation, combustion and oxidation, fires, explosions, rock dusting, rescue and recovery work, explosives and blasting, timbering, drainage, compressed air; related mathematics. 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: Production methods (anthracite and bituminous), equipment, ventilation practices, transportation; related mathematics and expression aids. 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 used in mechanized mining of coal from the standpoints of use, construction, operation, and mechanical maintenance; related mechanics and strength of materials; shopwork. 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.


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: Coal cleaning methods and equipment; laboratory analysis and plant control; related mathematics. Text material: Jones, D. C., Mining Mathematics, 2nd ed., Mineral Industries Extension Services, $1.75, and Coal Preparation, edited by D. R. Mitchell, AIME, $8.00. 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:

PETROLEUM AND NATURAL GAS EXTENSION

Three different three-course curriculums 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. There are no prerequisites for the initial course in each curriculum, but completion of high school mathematics, physics, and chemistry is desirable preparation for this preparatory course. Lack of this training does not exclude a student from a class; however, more intensive study of the course fundamentals will be necessary for such students.

NATURAL GAS ENGINEERING

Large demands for natural gas have forced the gas industry in the State to develop existing properties more extensively, 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.


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.


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. 909X. SECONDARY RECOVERY OF OIL: Secondary recovery of oil by water flooding and injected gas drive; 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, and 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, 4¼ units.

CER. 922X. GLASS TECHNOLOGY II: Melting and forming of glass products; physical, chemical, and mechanical properties of glasses. Prerequisite:

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, 4 1/2 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, 4 1/2 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, 4 1/2 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, 4 1/2 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, 4 1/2 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, 4 1/2 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: 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. and Quirk, V. P., *Fuels and Combustion Fundamentals*, a mimeographed pamphlet, Mineral Industries Extension Services, $2.50. 72 hours, 4 1/2 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. 904X. PHYSICAL METALLURGY LABORATORY: Instruction in laboratory techniques; laboratory investigations of effect of heat treatment on the structure and properties of steel. Prerequisite: Met. 903X. 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, an additional supply will be sent upon payment of 25 cents per pad.

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 College 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 = 0-44 — 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


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

William R. Young, Supervisor of Correspondence Instruction, Central Extension, The Pennsylvania State College, State College, Pennsylvania.

CORRESPONDENCE COURSES IN EDUCATION AND PSYCHOLOGY


CORRESPONDENCE COURSES IN INDUSTRIAL EDUCATION AND INDUSTRIAL ARTS EDUCATION

S. Lewis Land, Head of Department of Industrial Education, The Pennsylvania 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


GEOG. 32C. GEOGRAPHY OF PENNSYLVANIA: (This course will not be offered until the revised textbook is available).

GEOG. 460C. POLITICAL GEOGRAPHY: Geographical foundations of political phenomena; significant geographic factors in growth and development of

**GEOLOGY**


**GEOL. 32C. HISTORICAL GEOLOGY:** 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., $6.25. Set of outline maps, $0.50. Set of geologic maps and fossils, $4.00. 24 assignments.


**GEOPHYSICS**


**METEOROLOGY**


**METEO. 310C. GENERAL METEOROLOGY:** The principles of modern synoptic meteorology, including such topics as fronts and air mass analysis; observations 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*, 2nd ed., McGraw-Hill Book Co., Inc., $7.00. 24 assignments.

**METEO. 315C. SYNOPTIC METEOROLOGY EXERCISES I:** Practice in surface and upper air weather codes and charts; elementary map analysis and weather forecasting. Prerequisite: Meteo. 310C. Textbook: Pulk and Murphy, *Workbook for Weather Forecasting*, 1st ed., Prentice-Hall, Inc., $3.75. 24 assignments.

**METEO. 316C. SYNOPTIC METEOROLOGY EXERCISES II:** Analysis of and practice weather forecasting from preplotted weather data representing typical weather situations. Prerequisite: Meteo. 315C. Textbook: none. Set of preplotted charts, $15.00. 24 assignments.

**METEO. 317C. SYNOPTIC METEOROLOGY EXERCISES III:** Continuation of Meteo. 316C involving more complicated weather situations. Prerequisite: Meteo. 316C. Textbook: Riehl, H., et al., *Forecasting in Middle Latitudes*, 1st ed., American Meteorological Society, $3.50. Set of preplotted charts, $10.00. 24 assignments.

*Phys. 265 is equivalent to requiring a one-year course in general physics (6 credits).*


METEO. 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: Meteo. 900C. Textbook: Caudle, F. L., *Workbook in Elementary Meteorology*, 1st ed., McGraw-Hill Book Co., Inc., $2.20. 8 assignments. Fee $9; 3 units.

MINERALOGY


Mineral Engineering

MINERAL ECONOMICS


MINING


MNG. 902C. INTERMEDIATE COAL MINING: Advanced ventilation, combustion and oxidation, fires, explosions, rock dusting, rescue and recovery work, explosives and blasting, timbering, drainage, compressed air; related mathematics. This course prepares for the mine foreman certificate examination. Prerequisite: Mng. 901C. Textbooks: Jones, D. C., *Mining

Fee $27; 9 units.

MNG. 903C. ADVANCED COAL MINING: Production methods (anthracite and bituminous), equipment, ventilation practices, transportation; related mathematics and expression aids. 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. 24 assignments.

Fee $27; 9 units.


Fee $27; 9 units.

NATURAL GAS ENGINEERING


Fee $27; 9 units.


Fee $27; 9 units.


Fee $27; 9 units.

PETROLEUM REFINING ENGINEERING


Fee $27; 9 units.


Fee $27; 9 units.


Fee $27; 9 units.

PETROLEUM PRODUCTION ENGINEERING


Fee $15; 5 units.

PET. E. 908C. PETROLEUM PRODUCTION TECHNOLOGY: Petroleum mineralogy and geology, origin and migration of petroleum, exploration, well testing and completion, reservoir engineering, 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.


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, fired 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 $21; 7 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. 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:** 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: Axelton, F. R. and Quirk, V. P., *Fuels and Combustion Fundamentals*, a mimeographed pamphlet, Mineral Industries Extension Services, $2.50. 12 assignments. Fee $13.50; 4½ 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.

Ceramics, Volume I ........................................... $3.50
Ceramics, Volume II ........................................... 3.50
Ceramics, Volume III ......................................... 4.00
Refractories ......................................................... 2.50
Coal Mining, Volume I, 3rd ed. ............................... 4.00
Coal Mining, Volume II, 3rd ed. ............................. 4.00
Coal Mining, Volume III, 3rd ed. ............................ 4.50
Mining Mathematics, 2nd ed. ................................. 1.75
Mechanized Mining Electrical Applications, 2nd ed. .... 4.50
Petroleum Engineering Fundamentals, 3rd ed. ............. 4.50
Petroleum and Natural Gas Production, 2nd ed. .......... 4.50
Natural Gas Engineering, 2nd ed. ............................ 4.50
Petroleum Refining, Volume II, 2nd ed. ..................... 4.50
Introduction to Physical Meteorology ....................... 3.50
Mineral Forecast 2000 A.D. ................................... 3.00
Mineral Industries Education .................................. 3.00

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

Addresses of Publishers of Textbooks Listed in Course Descriptions

American Meteorological Society .............3 Joy Street, Boston 8, Mass.
Thomas Y. Crowell Co.............432 Fourth Avenue, New York 16, N. Y.
Gray Printing Company ..............................................Falls Creek, Pa.
Harcourt, Brace and Co., Inc. ....383 Madison Avenue, New York 17, N. Y.
Industrial Publications, Inc........5 South Wabash Avenue, Chicago 3, Ill.
Macmillan Company .............60 Fifth Avenue, New York 11, N. Y.
McGraw-Hill Book Co., Inc........330 West 42nd Street, New York 18, N. Y.
Penns Valley Publishers, Inc. .121 South Frazier Street, State College, Pa.
Prentice-Hall, Inc .............70 Fifth Avenue, New York 11, N. Y.
The Garrard Press ..............Champaign, Ill.
John Wiley and Sons, Inc .........440 Fourth Avenue, New York 16, N. Y.