MINERAL INDUSTRIES
EXTENSION AND
CORRESPONDENCE

INSTRUCTION

CIRCULAR NUMBER 30
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>6</td>
</tr>
<tr>
<td>Mineral Industries Extension Services</td>
<td>8</td>
</tr>
<tr>
<td>Mineral Industries Extension Services Staff</td>
<td>13</td>
</tr>
<tr>
<td><strong>MINERAL INDUSTRIES EXTENSION INSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>Scope of the Work</td>
<td>14</td>
</tr>
<tr>
<td>Cooperation with State Agencies</td>
<td>14</td>
</tr>
<tr>
<td>Class Organization and Control</td>
<td>15</td>
</tr>
<tr>
<td>Courses, Curricula and Credits</td>
<td>16</td>
</tr>
<tr>
<td>Assistance in Class Organization Provided</td>
<td>17</td>
</tr>
<tr>
<td>MINERAL ENGINEERING—Mining Extension</td>
<td>20</td>
</tr>
<tr>
<td>Coal Mining</td>
<td>20</td>
</tr>
<tr>
<td>Mechanized Mining</td>
<td>22</td>
</tr>
<tr>
<td>Coal Preparation</td>
<td>23</td>
</tr>
<tr>
<td>Mine Surveying</td>
<td>23</td>
</tr>
<tr>
<td>Noncredit Mining Courses</td>
<td>24</td>
</tr>
<tr>
<td>Supervisory Training</td>
<td>25</td>
</tr>
<tr>
<td>MINERAL ENGINEERING—Petroleum and Natural Gas Extension</td>
<td>26</td>
</tr>
<tr>
<td>Natural Gas Engineering</td>
<td>26</td>
</tr>
<tr>
<td>Petroleum Refining Engineering</td>
<td>27</td>
</tr>
<tr>
<td>Petroleum Production Engineering</td>
<td>28</td>
</tr>
<tr>
<td>MINERAL TECHNOLOGY—Ceramics Extension</td>
<td>29</td>
</tr>
<tr>
<td>MINERAL TECHNOLOGY—Fuel Technology Extension</td>
<td>33</td>
</tr>
<tr>
<td>MINERAL TECHNOLOGY—Metallurgy Extension</td>
<td>33</td>
</tr>
<tr>
<td><strong>MINERAL INDUSTRIES CORRESPONDENCE INSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>Procedures to be Followed, and Other Information</td>
<td>36</td>
</tr>
<tr>
<td><strong>CORRESPONDENCE COURSES</strong></td>
<td></td>
</tr>
<tr>
<td>EARTH SCIENCES</td>
<td></td>
</tr>
<tr>
<td>Geography</td>
<td>42</td>
</tr>
<tr>
<td>Geology</td>
<td>43</td>
</tr>
<tr>
<td>Geophysics</td>
<td>44</td>
</tr>
<tr>
<td>Meteorology</td>
<td>44</td>
</tr>
<tr>
<td>Mineralogy</td>
<td>46</td>
</tr>
<tr>
<td>MINERAL ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>Mineral Economics</td>
<td>46</td>
</tr>
<tr>
<td>Mining</td>
<td>46</td>
</tr>
<tr>
<td>Natural Gas Engineering</td>
<td>47</td>
</tr>
<tr>
<td>Petroleum Refining Engineering</td>
<td>48</td>
</tr>
<tr>
<td>Petroleum Production Engineering</td>
<td>48</td>
</tr>
<tr>
<td>MINERAL TECHNOLOGY</td>
<td></td>
</tr>
<tr>
<td>Ceramics</td>
<td>49</td>
</tr>
<tr>
<td>Fuel Technology</td>
<td>51</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>51</td>
</tr>
<tr>
<td>Textbooks and Their Costs</td>
<td>Cover 3</td>
</tr>
<tr>
<td>Addresses of Publishers of Textbooks</td>
<td>Cover 4</td>
</tr>
</tbody>
</table>
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, at present, of less than college level work by reason of their subject matter, method of presentation, and specific utilization. The 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. Completion of a curriculum consisting of several industrial courses is rewarded with an industrial grade diploma. Informal class instruction in subjects for which credits are not given is also available upon request.

Courses offered through correspondence are available to individuals in other states and foreign countries as well as to residents of Pennsylvania. Both industrial grade and college level courses are offered. 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.

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

SHORT COURSES:

CORRESPONDENCE SUBJECTS:

DATA:
pertaining to the administration of the work.
FOREWORD

EDWARD STEIDLE, DEAN
SCHOOL
OF
MINERAL INDUSTRIES

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 nonmetallic 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 carried to the people and applied to the industries. Educational processes taken into the mines, mills, and plants result in the promotion of mutual understanding between employers and employees which is imperative for efficiency, safety, and economy of operation. The 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 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

D. C. JONES, DIRECTOR
Mineral Industries Extension Services
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 twelve 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, up-grading extension curricula on less-than-college-grade level; (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 less-than-college level 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. 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 five 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 all 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 1948, the Extension Services has provided training in mineral industries courses to 47,189 Pennsylvania workers through extension classes and to 1555 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 1931-48 is, therefore, (a) regular extension and correspondence instruction—48,744, (b) defense and war training—7138, or a grand total of 55,882 and an average over the 17-year period of 3286 persons annually. Recent surveys indicate that students from 512 communities in 36 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

MINERAL INDUSTRIES
EXTENSION SERVICES STAFF

Edward Steidle, Dean, School of Mineral Industries
Donald C. Jones, Director, Extension Services
Hallye M. Lawrence, Secretary to the Director
Carolyn L. Wells, Secretary
Theresa A. Fike, Stenographer

Ceramics
James R. Coxey, Supervisor

Fuel Technology
Frederick R. Axelson, Supervisor*

Metallurgy
James W. Thurman, Supervisor
Louis F. Haller, Assistant Supervisor

Mining
Joseph W. Hunt, Supervisor
Harold Davis, Assistant Supervisor

Petroleum and Natural Gas
Oscar F. Spencer, Supervisor

Supervisory Training
Robert B. Hewes, in Charge*

*Assists in organization and supervision of mining extension classes.
MINERAL INDUSTRIES
EXTENSION INSTRUCTION

SCOPE OF THE WORK

Mineral industries extension instruction is an adult education program designed to provide training for workers in the mineral industries of the Commonwealth of Pennsylvania. The courses offered in this program are, at present, of less than college level, although college credit classes have been conducted off the campus in the past and will be available in the future when there is sufficient demand. The general purpose of the program is to upgrade mineral industries workers by providing an overall view of each industry and encouraging 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

Courses offered by the Extension Services may be taken in several types of classes. By far the greater number of classes are of the type 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 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 a 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 recommendations 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 operat-
ing 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

Courses offered by Mineral Industries Extension Services are designed to provide students with information directly related to the type of work
done in their normal employment. Certain courses have been grouped into curricula because the material offered in these courses cannot be given in one year or term of study, and it was deemed good practice to provide two or three terms of study, with the material given in consecutive courses arranged in a logical ascending order of importance. Other courses, related to but not strictly a part of a curriculum, have been provided to give "specific" training as compared to the "general" training of curricula. These specific training courses are also known as "terminal" courses because they are complete and not necessarily preparatory for some advanced course. In certain instances terminal courses are given to a class after it has completed a curriculum. A description of the courses offered by the Extension Services is given in the following section of this bulletin.

Credits offered for completion of a particular course are termed "units" and are known as "industrial" credits. At the present time there are no college-credit courses offered in extension classes. Certificates are given for completion of a course; a Mineral Industries Extension Services diploma is given for completion of a curriculum. One unit of credit is granted for 16 hours of class instruction, and the number of units per course is based on the total length of the course. Many of the courses are designed for 144 hours of operation per school term, others for 80 hours, and still others for 48 hours.

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.

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 indi-
viduals 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
NEW MINERAL SCIENCES BUILDING

Mineral Industries Extension Services will have quarters in the new Mineral Sciences Building now under construction.
MINERAL ENGINEERING

Extension courses in mineral industries subjects 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 in 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.

MINING EXTENSION

The mining extension program consists of a curriculum in coal mining, plus short credit courses in mechanized mining, coal preparation, and mine surveying. Noncredit or informal instruction courses paralleling the credit courses are also available, and these include the supervisory training course which is expected to become as important in the training of mine supervisors as the coal mining curriculum in the training of men to become supervisors.

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 comple-
tion of a single course, and preferably of all three courses, will make him more valuable to his employer and the particular industry in which he is engaged.

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

**MNG. 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. It includes basic studies in English, geology, arithmetic, mining physics, mining chemistry, mine gases, detection of gases, and elementary mine ventilation. The mining laws of Pennsylvania are studied as related material. This course prepares for the fire boss certificate examination. Textbooks: Jones, D. C., *Coal Mining, Volume I*, Mineral Industries Extension Services, $3.50. *Mining Laws of Pennsylvania.* 144 hours, 9 units.

**MNG. 902X. INTERMEDIATE COAL MINING:** This course includes basic studies in mine lighting, advanced mine ventilation, algebra, combustion and oxidation, mine fires, mine explosions, rock dusting, mine safety and accident prevention work, mine surveying and mapping, explosives and blasting, and mine electricity. This course prepares for the mine foreman certificate examination. Prerequisite: Mng. 901X. Textbook: Jones, D. C., *Coal Mining, Volume II*, Mineral Industries Extension Services, $3.50. 144 hours, 9 units.

**MNG. 903X. ADVANCED COAL MINING:** This course includes basic studies in trigonometry, ventilation practices, mining methods, mine timbering methods, steam, compressed air, mine drainage, mine haulage, and preparation of coal. Although not considered as an examination-preparation course, it provides information of value to those persons who expect to qualify for mining certificates of rank higher than foreman. Prerequisite: Mng. 902X. Textbook: Jones, D. C., *Coal Mining, Volume III*, Mineral Industries Extension Services, $3.50. 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. It is possible that all of the mechanized mining courses will eventually be offered in similar schools, centrally located for mining areas. The coverage and general purpose of each course is as follows:

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

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 elec-

MNG. 906X. **MECHANIZED MINING SUPERVISORY COURSE:** Designed for persons now serving in a supervisory capacity in a mechanized mine, or who expect to serve in a supervisory capacity. Group discussions under the guidance of a trained group leader, centering around the main topics of job instruction, time studies, operating cycles, operating control, and cost control. Basic background material is provided the group leader; there is no text material developed for student use. 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 loading devices that load any and all material shot down at the coal faces have given impetus to the development and more widespread use of cleaning plants. There is a growing need on the part of cleaning plant personnel for knowledge of fundamental principles of operation necessary to maintain the quality of product desired from each plant. The general purpose and coverage of the course is as follows:

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*, 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*, 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*, John Wiley and Sons, Inc., $4.50; *Mining Laws of Pennsylvania*. 96 hours, 6 units.

**NONCREDIT MINING COURSES**

Mineral Industries Extension Services will develop short noncredit courses for specific mining applications where the requests for any particular course warrants the expenditure of effort. Typical of this kind of work are the Elementary Mine Surveying and Shothirer's and Machine Runner's courses. The specific need of the applicant is served by a short course, whereas a longer and more involved course which provides the same information at certain points in the training might prevent the development of the class. Specific application courses are given in fee classes, with either the sponsoring company or the students taking care of all expenses in connection with the program. The following descriptions will show the coverage and general purpose of the two courses now available:
ELEMENTARY MINE SURVEYING: Provides foremen and other supervisors of small coal mines with the knowledge necessary to use a transit in running levels and in turning angles or projecting lines to keep the mine workings reasonably accurate between the semi-annual surveys made by a licensed engineer or surveyor. It consists of instruction on the adjustment and operation of the transit, and in running simple surface and underground surveys. Calculations are kept to a minimum since this is not a regular surveying course. No text materials are used. No credit.

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

SUPERVISORY TRAINING

The complexity of modern mining methods, especially where all productive operations involve the use of machinery, has placed a tremendous responsibility on the supervisor in charge of production, either for the entire mine or for any part. Supervisory duties now require a knowledge of machinery, of engineering as applied to the mining of coal, of safety procedures to be followed, of cost analysis, and of human relations. It is rare when all of these qualifications are found in an applicant for a supervisory job; yet the necessity of having supervisory personnel who are capable of discharging their duties satisfactorily in respect to all of these phases of their work is universally recognized, and many companies have attempted to overcome supervisors’ deficiencies through training programs.

The development of a training program that will be applicable to any group of mine supervisors must allow for extreme flexibility in its application because no two groups of supervisors will have identical problems. The Supervisory Training program provides this flexibility by utilizing the “conference” method of problem discussion. The length of the program developed for a particular company depends on the number of supervisory phases to be included, and details of the entire program, including length, sessions per weeks, length of each session, personnel involved,
etc., are worked out with management in advance. Provisions have been made whereby groups that recognize their deficiency in a particular technical subject are given an opportunity to take classroom instruction in this subject.

At present Supervisory Training is limited to the operation of a few experimental programs, with all conferences in charge of a College staff member. Later, this type of training will be expanded as additional conference leaders, either developed locally or added to the College Staff, become available. Programs are, for the present, limited to employees of any sponsoring company. Later, it is hoped, area programs will be developed so that supervisory employees from a number of companies may attend. Supervisory Training constitutes "informal instruction" for which no credits are granted. It does not conflict with MNG. 905X which deals with training of supervisors in specific mechanized mining studies.

PETROLEUM AND NATURAL GAS EXTENSION

Three different curricula covering the fields of natural gas, petroleum refining, and petroleum production constitute the work in petroleum and natural gas extension. The curricula in natural gas and petroleum refining offer three courses; that in petroleum production now offers two courses, with the third under development at the present time. The courses in these curricula 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 has 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


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*, 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*, Mineral Industries Extension Services, $4.50. 144 hours, 9 units.


**PETROLEUM PRODUCTION ENGINEERING**

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 in a period of the greatest demand in history. 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


80 hours, 5 units.

**SECONDARY RECOVERY OF OIL:** This course will be available about September, 1949. The textbook is in process of being written and will cover secondary recovery of oil by two different methods, water flooding and air-gas repressuring.

**MINERAL TECHNOLOGY**

Mineral technology courses are divided into ceramics, fuel technology, and metallurgy extension programs. The fuel technology work is newly developed and should find widespread application. The metallurgy extension work at present is predominantly ferrous metallurgy training, but plans are under way to give nonferrous and foundry training more emphasis in the future.

**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. Two types of course application to fit the needs of industrial workers are available.

The first type of course application is that which has been followed for a number of years. Five separate three-course programs, each designated as a curriculum in ceramics, are given in this system, each course of 144 hours duration. The fundamentals of each curriculum are presented in the first two courses which are common to all inasmuch as all theory of the various ceramic processes is based on silicate technology. In the third course specialization is provided in Heavy Clay Products, Whitewares, Refractories, Enamels, and Glass. Any student who satisfactorily completes two courses and one of the specialized third courses is presented a diploma in Ceramics.

A second type of course application, introduced for the first time this term, embraces studies chosen from the course material given in the first type of application and applied more 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 48 hours duration. This type of application presupposes the ability of the student to understand the chemistry, physics, and mathematics given as Ceramics 901X under the other system. Where such prerequisite knowledge is lacking the student will be required to remedy this situation. There is a certain amount of material common to all of the courses, but it is not necessarily given at the same period in each course and thus does not lend itself to a “common” preparatory course.

**CER. 901X. FUNDAMENTALS OF CERAMICS:** An introduction to the entire field of ceramics, the relation of the various ceramic industries to each other, practical mathematics, chemistry, physics, including electricity and mechanics. The first year is a preparation for the specialized studies of

**CER. 902X. BASIC CERAMIC TECHNOLOGY:** Part I—Raw materials; including elementary mineralogy, the occurrence, uses and properties of ceramic raw materials and raw material preparation, which includes grinding and mixing. Part II—the production, control, and application of heat; including temperature measurement by instruments and cones, fuels, and their combustion, and refractories for furnaces. Part III—silicate chemistry, including the interpretation of melting and crystallization diagrams for silicate mixtures. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.50. 144 hours, 9 units.

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

**Clay Products and Whitewares:** for employees in either heavy clay products plants or whiteware plants. The work is given in three parts: Part I—general manufacturing processes, including clay forming, drying and driers, and firing and kilns; Part II—calculations and testing; including calculations for bodies and glazes, standard test procedures for various properties of clays and clay products and test apparatus; Part III—the properties and specifications of the heavy clay products, the properties and bodies of whiteware products, and glazes and glazing. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, $4.00. 144 hours, 9 units.

**Refractories:** General methods of manufacture of all types and compositions of refractory brick shapes, their general properties, and their applications in various types of industrial furnaces; the fireclay, silica, magnesite, chrome, silicon carbide and carbon refractories. Textbook: Norton, F. H., *Refractories*, McGraw-Hill Book Co., Inc., $7.50. 144 hours, 9 units.


**Enamels:** The enameling industry and its raw materials, the smelting and fritting of enamels, their application and firing on cast iron and sheet steel, the metallurgy of the irons and steels used for enameling.

**CER. 921X. GLASS TECHNOLOGY I:** Applications to the glass industry of the occurrence, uses, and properties of ceramic raw materials, pyrometry, fuels and their combustion, and refractories. Textbook, McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.50. 48 hours, 3 units.


**CER. 923X. WHITEWARES I:** Applications to the whitewares industry of the occurrence, uses, and properties of ceramic raw materials, pyrometry, fuels and their combustion, and refractories. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.50. 48 hours, 3 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. 48 hours, 3 units.

**CER. 925X. REFRACTORIES I:** Applications to the refractories industry of the occurrence, uses, and properties of ceramic raw materials, pyrometry, and fuels and their combustion. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.50. 48 hours, 3 units.

**CER. 926X. REFRACTORIES II.** Refractories technology and practice. Prerequisite: Cer. 925X. Textbook: *Refractories*, a mimeographed pamphlet, Mineral Industries Extension Services, $1.50. 48 hours, 3 units.

**CER. 927X. HEAVY CLAY PRODUCTS I:** Applications to the heavy clay products industry of the occurrence, uses, and properties of ceramic raw materials. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.50. 48 hours, 3 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*, and McNamara, E. P., *Ceramics, Volume III*, $7.50. 48 hours, 3 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 need to secure better fuel utilization. At present this program is in the development stage and only one course, considered a survey course for fuel technicians in steam generating plants using solid fuels, is available. Adaptation of this course to other fuel using industries could readily be made if there was a demand for it. Development of other courses in fuel technology is planned for the future.

FUEL T. 901X. 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. Textbooks: de Lorenzi, Otto, Combustion Engineering, Combustion Engineering Company, Incorporated, $3.50; Fuels and Combustion, Mineral Industries Extension Services, $1.00. 144 hours, 9 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.

It is natural that the field of ferrous metallurgy should occupy a prominent place in such an extension program. The courses in this field have been developed, after consultation with industrial leaders and personnel directors, to satisfy the needs of a wide range of employees within the in-
dustry, with recognition of the wide range of previous formal education. The work commences with a review of the basic sciences necessary to an understanding of the advanced work to be given later. After considering subject matter of importance to metallurgy in general, a study is made of the entire field of ferrous metallurgy, from raw materials to finished product, concluding with the more theoretical aspects of the subject as they appear in physical metallurgy. The first three courses, each comprising 144 hours or one year of study, constitute a curriculum. A fourth course, offered where there is sufficient demand, consists of laboratory work.

Text material for the courses included in the curriculum have been developed by staff members of the Extension Services. This material is presented in a logical ascending order, each volume presenting advanced information that, normally, requires a study of the previous volume to be completely understood. It is, therefore, desirable to take these courses in their normal order, although this is not absolutely necessary in every case. A prerequisite formal training in high school chemistry and physics is desirable, but lack of this training does not prevent a student from entering the class; more intensive study of the fundamentals provided in the initial course will be necessary.

A similar curriculum in nonferrous metallurgy has not been developed as yet; there has been no urgent demand from the industry, due largely to its widely scattered nature and the generally small size of individual plants. There is, however, a need for training within nonferrous plants, and the Extension Services are ready to serve the industry by assisting individual companies to develop courses which will be of use to their personnel. The course, Introductory Physical Metallurgy, offers a study of general physical metallurgy which includes nonferrous as well as ferrous metallurgical applications.

It is recognized that the present courses in both ferrous and nonferrous metallurgy may not be suitable for certain plants, such as small fabricating plants and foundries. The development of special applications of these courses, or of new courses if necessary, will be considered by the Extension Services where such a request is made by industry.

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,

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*, McGraw-Hill Book Co., Inc., $5.50.

MET. 904X. PHYSICAL METALLURGY LABORATORY: Laboratory technique and the use of laboratory equipment, calibration of base metal thermocouples, micro-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.

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, including brasses, bearing metals, and aluminum alloys; application to engineering use of these alloys; constitution of steels; theory of heat treatment of steels; alloying elements in steels; application to engineering use of steels and cast irons; powder metallurgy. Prerequisite: graduation from a four-year high school course, including chemistry and physics.
MINERAL INDUSTRIES
CORRESPONDENCE INSTRUCTION

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

GROUPS FOR WHOM COURSES ARE INTENDED

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

(1) High school graduates who are unable to continue their education immediately. Through correspondence study they can earn advanced credits while they are working to obtain means for financing the cost of a college education.

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

(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.

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

GENERAL INFORMATION

A student may enroll at any time during the year.

A correspondence course may be completed without interruption, as rapidly or as slowly as desired, at home or elsewhere in spare hours, unhindered 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 nonresident student by the College Examiner. Therefore, he should communicate with the College Examiner before enrolling for a correspondence subject.

All questions concerning credit for subjects studied elsewhere must also be directed to the College Examiner.

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

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

The Registrar of the College is officially notified when a student successfully completes a college credit subject.

A grade report is issued from the Registrar's office to each student upon the successful completion of a college credit correspondence course. Official transcripts of a student's Correspondence Study record will be mailed by the Registrar of the College upon payment of 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 subject is listed with the course description. This fee covers lesson instructions, postage paid by the College in returning lesson reports, and the service of the instructor. An extra postage fee of $1.00 per subject will be charged for students outside of the United States.

TEXTBOOKS

Any additional costs for texts or other material are given with the course description. All required text material may be obtained through Mineral Industries Extension Services.

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 for 25 cents.

FINAL EXAMINATIONS

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

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

\[ \begin{align*}
3 &= 90-100 \text{ inclusive—excellent} \\
2 &= 80-89 \text{ inclusive—good} \\
1 &= 70-79 \text{ inclusive—fair} \\
0 &= 60-69 \text{ inclusive—passing} \\
-1 &= 45-59 \text{ inclusive—failure} \\
-2 &= \text{below 45—failure}
\end{align*} \]

CERTIFICATES AND DIPLOMAS

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

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

Credits earned either by class or correspondence study are applicable toward a 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

CORRESPONDENCE COURSES IN EDUCATION AND PSYCHOLOGY

C. O. Williams, 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 Pennsyl-
vania State College, State College, Pennsylvania.

CORRESPONDENCE COURSES OFFERED THROUGH
THE UNITED STATES ARMED FORCES INSTITUTE
AND THE VETERANS ADMINISTRATION

Correspondence courses in mineral industries subjects, including many
of those appearing in this catalogue, are available to personnel of the
United States Armed Forces and to discharged veterans, under the con-
tracts between the College, and the U.S.A.F.I. and the Veterans' Adminis-
tration, severally. 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 or vet-
erans' bureau office should be consulted regarding enrollment and processing
of the application.
CORRESPONDENCE COURSES
IN MINERAL INDUSTRIES

EARTH SCIENCES

GEOGRAPHY


Fee $27; 3 college credits.

GEOG. 30C. GEOGRAPHY OF NORTH AMERICA: America north of the Rio Grande; industries, the farms, forests, towns, and highways that have developed as a result of the human occupation and use of each of the regions with its characteristic conditions of climate, topography, soil drainage, and natural resources. Textbook: Smith, J. Russell, and Phillips, M. Ogden, North America, Harcourt, Brace and Co., Inc., 1940, $5.50. Set of 12 maps, No. DD5, A. J. Nystrom Co., Chicago, Ill., $0.36. 24 assignments.

Fee $27; 3 college credits.

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

**GEOG. 42C. GEOGRAPHY OF EUROPE:** The geographic factors in the economic, social, and political progress of the nations; emphasis on the major natural regions, distribution of resources, industrial development, and major problems of the continent in light of the geographic background. Prerequisites: Geog. 24C, 26C. Textbook: Hubbard, G. C., The Geography of Europe, D. Appleton-Century Co., 1937, $5.00. 24 assignments.

Fee $27; 3 college credits.

**GEOLOGY**

**GEOL. 30C. PHYSICAL AND HISTORICAL GEOLOGY:** Combines Geol. 31C and 32C; 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, second edition, John Wiley and Sons, Inc., $4.50. Set of 15 topographic maps, $3.00**. 24 assignments.

Fee $27; 3 college credits.


Fee $27; 3 college credits.

**GEOL. 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. Prerequisites: Geol. 31C. Textbook: Schuchert, C., and Dunbar, C. O., Textbook of Geology, Part II, Historical Geology, fourth edition, John Wiley and Sons, Inc., $4.50. Set of outline maps, $0.50**; set of geologic maps and folios, $4.00**. 24 assignments.

Fee $27; 3 college credits.

---

* Students who have taken Geog. 34C should elect this course rather than Geol. 31C.

** Do not include cost of maps in making prepayment for course upon registration. Student should purchase maps directly from Professor C. W. Robinson, Division of Geology of this School.
GEOL. 451C. ECONOMIC GEOLOGY: The more important metallic and non-metallic mineral deposits, gold, silver, lead, zinc, iron, coal, oil, clays, etc. Mineralogy, geological relationships, geographical distribution and economic considerations are emphasized. Prerequisites: Geol. 31C, 32C, and Min. 31C. Textbook: Bateman, A. M., Economic Mineral Deposits, John Wiley and Sons, Inc., $7.00. Set of outline maps, $0.50**. 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 radio-active 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, McGraw-Hill Book Co., Inc., $6.00. 24 assignments. Fee $27; 3 college credits.

METEOROLOGY

METEOR. 300C. WEATHER AND MAN: A nontechnical treatment of the fundamentals of meteorology, such as weather elements, air masses, fronts, cyclones and anticyclones, etc., and evaluation of weather and climate as related to agriculture, architecture, aviation, public utilities and transportation, business and industry, health and recreation. Textbook: Neuberger, H. and Stephens, F. B., Weather and Man, Prentice-Hall, Inc., 1948, $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, McGraw-Hill Book Co., Inc., 1944, $5.50. 24 assignments. Fee $27; 3 college credits.
METEOR. 314C. PRACTICAL EXERCISES IN METEOROLOGY: (1) The mean conditions of the atmosphere: distribution of temperatures, pressures, and rainfall. (2) Instruments and methods of observation: instrument scales, barometer reductions, humidity, and pilot balloon observations. (3) Exercises in dynamic meteorology: composition of the atmosphere, hydrostatic equation, wind equations, geostrophic-wind scale, thermodynamic diagram, frontal slopes, isobaric analysis, graphical operations on the thermodynamic diagram, thunderstorm analysis, diurnal pressure variations, barometric tendencies, displacement of pressure systems and fronts. Prerequisites: one year of general college physics and mathematics including differential calculus, and three college credits in an advanced course in meteorology; may be taken concurrently with Meteor. 310C. Textbook: Spilhaus, Athelstan F., and Miller, James E., Workbook in Meteorology, McGraw-Hill Book Co., Inc., 1942, $3.00. 24 assignments.

Fee $27; 3 college credits.

METEOR. 372C. PHYSICAL CLIMATOLOGY: Climatological observations (including routine observations and special tests for solar radiation, evaporation, cooling power), statistical treatment of observations, microclimatic and bioclimatic problems, use of climatic data in mining, medicine, agriculture, and meteorology; physical scheme of distribution of climatological elements on the earth. Prerequisites: Phys. 215. Textbook: Landsberg, Helmut, Physical Climatology, Gray Printing Co., 1944, $3.50. 24 assignments.

Fee $27; 3 college credits.


Fee $9; 3 units.

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

Fee $9; 3 units.

** Do not include cost of maps in making prepayment for course. Student should purchase maps directly from Professor C. W. Robinson, Division of Geology of this School.
MINERALOGY

MIN. 53C. ELEMENTARY MINERALOGY: For students in the Schools of Agriculture and Chemistry and Physics. Prerequisite: Chem. 1 or 3. Textbook: Dana, E. S., Minerals and How to Study Them, John Wiley and Sons, Inc., $2.50. Tray of minerals: Ward's Natural Science Establishment, $8.75. 16 assignments. Fee $18; 2 college credits.

MINERAL ENGINEERING

MINERAL ECONOMICS


MINING

MNG. 901C. ELEMENTARY COAL MINING: Designed to provide the knowledge necessary to obtain and hold supervisory and other advanced types of jobs around coal mines. It includes basic studies in English, geology, arithmetic, mining physics, mining chemistry, mine gases, detection of gases, and elementary mine ventilation. The mining laws of Pennsylvania are studied as related material; prepares for the fire boss certificate examination. Textbooks: Jones, D. C., Coal Mining, Volume I, Mineral Industries Extension Services, $3.50. Mining Laws of Pennsylvania. 24 assignments. Fee $27; 9 units.

MNG. 902C. INTERMEDIATE COAL MINING: Includes basic studies in mine lighting, advanced mine ventilation, algebra, combustion and oxidation, mine fires, mine explosions, rock dusting, mine safety and accident prevention work, mine surveying and mapping, explosives and blasting, and mine electricity; prepares for the mine foreman certificate examination. Prerequisite: Mng. 901C. Textbook: Jones, D. C., Coal Mining, Volume II, Mineral Industries Extension Services, $3.50. 24 assignments. Fee $27; 9 units.

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

MNG. 905C. MECHANIZED MINING ELECTRICAL APPLICATIONS: Intended for mine maintenance men but can be utilized as an upgrading program by other types of mine workers; provides the basic principles of proper and "permissible" operation of mechanized mining electrical equipment and proper maintenance procedure. Related mathematics and that portion of the mining laws of Pennsylvania governing the operation of electrical equipment in gassy coal mines are studied as related material. Textbooks: Jones, D. C., Mechanized Mining Electrical Applications, and, Mining Mathematics, Mineral Industries Extension Services, $5.50. 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, Mineral Industries Extension Services, $4.00. 24 assignments. Fee $27; 9 units.


PET. E. 903C. NATURAL GAS ENGINEERING: Practical engineering training in gas handling practices for men employed in the natural gas industry. The course is divided into three sections. The first includes natural gas economics, measuring properties of natural gas, and gas well completion.

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, Mineral Industries Extension Services, $4.00. 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*, Mineral Industries Extension Services, $4.00. 14 assignments. Fee $15; 5 units.


**SECONDARY RECOVERY OF OIL:** This course will be available about September, 1949. The textbook is in process of being written and will cover secondary recovery of oil by two different methods, water flooding and air-gas repressuring.

---

**MINERAL TECHNOLOGY**

**CERAMICS**

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

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

**CER. 911C. CERAMIC RAW MATERIALS:** The occurrence, properties, uses, and preparation of ceramic raw materials including silica, alumina, feldspars, lime, magnesia, dolomite, the fluorine minerals, the alkali minerals, the boron minerals, all with special emphasis on clays; the industrial operations of crushing, grinding, screening, and mixing; the mineralogy, geology, chemistry, and physics of the materials. Textbook: McNamara, E. P., *Ceramics, Volume II*, Mineral Industries Extension Services, $3.50. 18 assignments. Fee $20.25; 7 units.

**CER. 912C. FORMING AND GLAZING HEAVY CLAY PRODUCTS:** The manufacture and properties of heavy clay products with special reference to the


CER. 914C. CERAMICS CALCULATIONS AND TESTING OF CLAYS AND CLAY PRODUCTS: Calculations involved in working with body and glaze batches and computing the various physical properties of raw clays, fired clay products, and whitewares. Included are the various physical and chemical tests commonly made on raw clays and fired bodies as well as the apparatus involved in the various tests. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, $4.00. 18 assignments. Fee $20.25; 7 units.


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

CER. 917C. FORMING AND GLAZING WHITEWARES: The properties, manufacture, and glazing of whiteware products including vitreous and semi-vitreous products, and a detailed study of the various methods of forming clay wares such as throwing, hand molding, jiggering, dry pressing, and slip casting. Textbook: McNamara, E. P., *Ceramics, Volume III*, Mineral Industries Extension Services, $4.00. 18 assignments. Fee $20.25; 7 units.

CER. 918C. GLASS: Glass manufacture, including glass raw materials and their preparation, batch preparation and calculations, combustion and

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

**FUEL TECHNOLOGY**

**FUEL T. 901C. 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. Textbooks: de Lorenzi, Otto, *Combustion Engineering*, Combustion Engineering Company, Incorporated, $8.50; *Fuels and Combustion*, Mineral Industries Extension Services, $1.00. 24 assignments. Fee $27.00; 9 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 making, 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: Tschert, E. J., *Ferrous Metallurgy, Volumes I and II*, McGraw-Hill Book Co., Inc., $4.50 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 specification of steel; includes laboratory technique, nondestructive testing, physical testing, constitution of alloys, the iron-carbon diagram, the metallography of steel castings and cast iron, the mechanical treatment of steels, theory of hardening, grain size, case hardening, general effects of alloying elements, alloy steels such as stainless and tool steels, cast irons and their treatment. Prerequisite: Met. 900C or graduation from a four-year high school course including chemistry and physics. Textbook: Teichert, E. J., *Ferrous Metallurgy, Volume III*, McGraw-Hill Book Co., Inc., $5.50. 24 assignments. Fee $27.00; 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, including brasses, bearing metals, and aluminum alloys; application to engineering use of these alloys; constitution of steels; theory of heat treatment of steels; alloying elements in steels; application to engineering use of 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*, McGraw-Hill Book Co., Inc., 1942, $2.75. 24 assignments. Fee $27.00; 9 units.