EDUCATION FOR VICTORY

By PROF. FRANKLIN THOMAS

The Engineering, Science, and Management Defense Training Program at Caltech is briefly reviewed in the following. A complete list of courses now being offered is given. Professor Thomas goes on to explain the faculty decision against an accellerated under graduate program during the summer months and the elimination of this year's spring vacation.

One of the less spectacular but nevertheless highly useful aspects of converting the resources of the nation to a war production basis has been the training program in the engineering and science fields to meet emergency needs. In this program, the California Institute of Technology has participated on an extensive basis, particularly with reference to the fields in which it is specially fitted in both personnel and facilities.

In the early period of the defense program, the deficiencies of the nation in ships and aircraft were particularly recognized. With the rapid expansion of production facilities in these directions it was recognized that competent engineers and supervisors for those activities in the required number could only be achieved through the adaptation of persons with fundamental engineering or scientific training to the special applications of these principles to meet the new demands.

In July of 1940, shortly after Hitler had over-run the Low Countries and reached the English Channel, a group of engineering educators was assembled by Dr. John W. Studebaker, the Commissioner of the U. S. Office of Education, and the pattern of the training program which has subsequently proved so effective was evolved and a Congressional appropriation was secured to inaugurate the Engineering Defense Training courses. For administrative purposes the country is divided into twenty-two geographical regions. Professor Robert L. Daugherty is Regional Adviser for the region including southern California, Arizona, New Mexico and western Texas. This program has expanded under the Engineering, Science and Management Defense Training Program until there are now 140 institutions conducting these courses with a total enrollment to date during the current fiscal year exceeding 250,000. The corresponding figure for the Institute alone approximates 3000. This number represents both those courses which have been completed and those which are now in progress, but the number currently enrolled in courses conducted by the Institute is approximately 1500.

In addition to the E.S.M.D.T. program, both the Army and the Navy have arranged independently for the training of men in specialized fields of service. During the last two college years there have been groups of meteorology cadets detailed to the Institute for a nine months period of training. These cadets periodically represented 120 selected college graduates from engineering or science courses, who upon completion of their training period were commissioned as 2nd Lieutenants in the Army, Ensigns in the Navy, and Civil Service appointees with the Weather Bureau. The third such group is now under way. Accommodation for such enlargement of the number of students in Meteorology was provided by the utilization of much of the space in the Mudd Laboratory of the Geological Sciences.

Photo by O. K. Harter.

Fig. 1: **ESMDT Welding Class in action at C.I.T.**

Special training courses have students representing three general types. The numerically larger group is that in which the students are nearly all employed in the local industries and are taking advantage of the courses to improve their qualifications or to adapt themselves to some new type of employment more directly related to the war production needs. Both during the academic year and during the summer vacation there are groups of Army and Navy officers detailed to the Institute for special training as represented by courses arranged to meet their requirements and given as part of the E.S.M.D.T. plan. Representing the latter group is a class of Field Artillery Officers, which during the past few months has been occupied with a course in Military Meteorology, supervised by Dr. Th. von Karman. During the summer of 1941 and in prospect for the summer of 1942, there was a three months course in Aeronautical Engineering for newly commissioned Naval Ensigns who had just completed undergraduate courses in Engineering or Physics. The third group to be accommodated during the summer of 1941 was composed of civilians who were in a position to put in full time for the three month period. One group was enrolled in Production Engineering, another was enrolled in an introductory course in Electronic Circuits and Apparatus. The course in Aeronautical Engineering also included some civilians.

The following list of courses which have been offered or are in progress for the current year, represent a wide scope of specialized interest:—

Aircraft Production Illustration
Aircraft Power Plant Installation Design
Engineering Mathematics (Higher)
Fundamentals of Engineering Mechanics and Mathematics
Production Engineering

Introductory Electronics
Electronic Circuits and Apparatus
Elementary Radio
Theory and Science of Electric Welding, I.
Theory and Science of Electric Welding, II
Die Design and Press Work
Elementary Naval Architecture
Materials and Metallography Laboratory
Engineering Materials (Metallic) comprising sections in
- Materials and Processes
- Physical Metallurgy
- Metallography Laboratory
- Spectro-Chemical Analysis Laboratory

Basic Electric Circuits & Machinery
Military Meteorology
Aeronautical Engineering
Introductory Industrial X-Ray Technique
Aircraft Descriptive Geometry
Aircraft Detail Design
Aircraft Fitting Analysis
Production Engineering comprising sections in
- Industrial Relations for Supervisory Personnel (3 sections)
- Industrial Management
- Time Study
- Methods Improvement through Motion Study
- Cost Analysis and Control
- Tool Planning
- Wage and Salary Determination and Job Analysis
- Production Control
- Selection and Placement of Personnel
- Techniques of Training Personnel
- Quality Control
- Plant Layout and Materials Handling
- Advanced Tool Planning
- Introduction to Aerodynamics
- Electrical Machinery
- Ultra-High Frequency Technique
- Theory & Art of Resistance Welding
- Aircraft Production Design
- Strength of Materials
- Advanced Die Design
- Highway Engineering
- Engineering Materials (Metallic)
- Aerial Bombardment Protection
- Introductory Industrial X-Ray Technique
- Elementary Jig & Fixture Laboratory
- Advanced Jig & Fixture Laboratory
- Tool Engineering
- Theory of Aircraft Instrumentation
- Technical Drafting for Engineers
- Surveying Instruments and Procedure, II.
- Plane Table Topography
- Fundamentals of Radio
- Production of Strategic & Essential Minerals
- Marine Engineering, III.
- Radio Engineering
- Technical Report Writing
- Theory & Technique of Optical Testing Methods
- Identification of Industrial Materials
- Applied Geophysics
- Radio at Ultra-High Frequency

The faculty and the administration of the Institute during recent weeks have given a great deal of study to the question as to whether the Institute would more effectively serve the national interest by adopting an accelerated program for its regular activities or maintain approximately a normal academic

Photo by O. K. Harter.

Fig. 2: **Evening class in the EE Lab.**

year and utilize the facilities of the Institute during the summer for special emergency training. At a faculty meeting on March 6, 1942, when the question was specifically considered, it was the judgment of the faculty that none of the usefulness of the Institute would be lost if the summer were to be used for special work and there would thereby be avoided many complications which would result from attempting to coordinate classes which would be running out-of-phase with each other and many acute financial problems of students.

As indications developed of the desire of the Army and the Navy to assign newly commissioned officers to the Institute for special courses during the summer and, somewhat earlier than the Institute's usual closing date, the faculty also voted to gain a week by eliminating the spring vacation and advancing the date of Commencement to June 5th. These large classes of young officers involve the use of the student houses and the training which is desired for these men can be provided by the especially qualified staff of the Institute and its corresponding equipment. There is an urgent demand for the production of the type of men trained by the Institute's regular courses, but this urgency must be weighed in the balance with the emergency nature of the training required by special groups. Furthermore, there is every indication that nearly all the undergraduate students will have opportunity to be usefully and lucratively employed during the coming summer in connection with war projects.

In addition to the large groups of officers and other men detailed here by the government for full-time courses during the summer, the Institute expects to offer both full-time and night courses for civilians to the limit of its capacity. Some of these classes may involve radical departures from the male student tradition of the Institute. Requests are being made by the aircraft and other industries that the diminishing number of young men available for drafting jobs be replenished by men above the age of 35 and also by women.

At present the greatest urgency for large numbers of people to be trained exists in the field of radio. The application of

this radio training is for communications of all types and services and also for the more advanced and highly specialized application of ultra-high frequency detection technique.

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The many instances which could be cited of benefits which have resulted from these Defense Training Courses are impressive. Many students have thus been able to enter in very useful and advantageous capacities industries with which they had had no previous experience or connection. Some very significant developments with widespread effects through large industries have evolved from the participation of various supervisors in industry in these courses as instructors. The time and effort which has been so sincerely applied to these courses by the many students enrolled have represented very definite and productive contributions to the national welfare.

ELECTRON MICROSCOPE

(Continued from page 12)

The same situation arises when the electrons come to the object. The number of electrons transmitted at a given point depends on the thickness in terms of grams per square cm. For that reason most electron microscope pictures appear to be shadows. The electrons pass around the object but penetrate it to only a very slight degree. Only when the thickness of object varies over a small range and is such as to permit some transmission of electrons at all points, can a gradation of blackness be produced in the image.

The light that passes through the object in an ordinary microscope must be brought to a focus to give the image. In the same way, the electrons that pass through the object must be focussed to produce the image. The objective lens produces an image with a magnification of almost 100 at the focus of the projection lens. This projection lens again focuses the electrons into a further enlarged second image at the photographic plate. These lenses are magnetic lenses that consist of a coil of wire surrounded by a steel armor. The armor has a small opening in it so that the lines of force bulge out into the electron path over only a very short distance. In this distance the focussing takes place. The focal length of such a lens depends on the current passing through it so that the process of getting correct positions of object and photographic plate is replaced by a simple adjustment of the current.

Much of the complication of an electron microscope is due to the fact that fairly high voltages must be used for accelerating the electrons, and that the whole electron path must be in a high vacuum. The vacuum must be so good that the electrons make no collisions during the whole distance of some six feet from the filament to the photographic plate. This requires continuous pumping with high speed pumps as well as arrangements of valves by means of which the object and the photographic plates can be inserted and removed.

The voltages used vary from a few thousand to over a hundred thousand. A high voltage produces fast electrons that will penetrate a greater thickness of matter, but lower voltages show a better contrast in the image. Above all it is necessary to hold the voltage constant within a few volts. For this purpose, fairly elaborate voltage regulators must be used, and this is one of the major problems of construction.

The electron microscopes of today are only in the beginning of their development, and they are far from realizing the theoretically attainable resolving power. This makes it an attractive field of study for the engineer and physicist, while the field of study opened up by its applications promises to close the gap between the visible and the molecular ranges of size.