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A SURVEY OF UNIVERSITY COURSES IN FIRE TECHNOLOGY IN THE UNITED STATES

by

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SUMMARY

A review has been made of American undergraduate courses specializing in fire technology. There are three full-time courses which are quite well established and one evening course established very recently. The majority of graduates have been employed by the American insurance organizations, but there are signs that the demand for these graduates is widening.

MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

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INTRODUCTION

In recent years fire problems have become more varied and difficult and fire losses and the cost of fire to the nation have increased considerably. However, there have also been advances both in the scientific understanding of fire and in the technology of assessing and handling fire problems. These changes call for more stringent training for all those who deal with fire. Broadly speaking this requirement covers three main professional groups, viz.;

Fire Brigade Personnel;

Fire Insurance Officers; and

Industrial Safety Officers and Consultants.

In this country there is no common background of professional education for these different groups and the question can legitimately be raised as to whether a common high standard of education and training in fire science and technology should now be provided. The general standard of professional education which is obtaining wide acceptance in this country is that of the university graduate. Thus the recently formed Council of Engineering Institutions representing thirteen major engineering institutions in this country have formulated their Common Part I and II Examination as being approximately equivalent to university degree standard, and will allow the possession of a university degree in many science and engineering subjects to exempt a candidate from this common examination (1).

To improve the standard of technological performance in what might be termed the "Fire protection industry", and to cater for future staff requirements, a reasonable case may be made for the establishment of either an undergraduate or post-graduate course in Fire Science and Technology. Such a course could provide an output of staff trained to the standard recognized as being necessary for a Chartered Engineer.

In the United States a number of university courses in fire subjects has existed for some time. It was thought that it would be a useful step to survey the content and experience of these courses, to provide guidance as to whether courses of similar standing would be beneficial in this country.

AMERICAN COLLEGES WITH FIRE COURSES

A list of nine universities and colleges with courses on fire was obtained from the United States' Embassy. All these colleges were approached and asked for information on their syllabus, the number of students they took and the jobs the students took up when they had completed the course.

The answers received indicated that only three colleges out of the nine provide a full-time under-graduate course leading to a degree. These are the Illinois Institute of Technology, the University of Maryland, and the Oklahoma State University. Another college, the State of Connecticut, Hartford State Technical Institute, provided a five-year evening school programme leading to a degree in Applied Science, and another, The New York State Community College, had drawn up a syllabus for a graduate course in Fire Science. The other four universities approached either did not provide any courses at all or provided only short-term courses or conferences.

CONTENT OF COURSES

A summary of the content of the three full-time under-graduate courses mentioned above is given in the Appendix I.

There are substantial similarities between these courses so detailed information is provided for only one of them, the course at The Illinois Institute of Technology (Appendix II).

Most of the graduates from all three of the university courses took up posts in the insurance industry, and this was reflected by a strong emphasis on insurance matters. However, all courses also gave much time to fire protection subjects, these being the main specialization of the Fire Protection Departments of the universities in which the courses were given. In addition, use was made of the programmes drawn up from other subjects in the universities. These other subjects included Mathematics, Physics, Chemistry, Engineering Sciences, and Economics, the standard of instruction in them being identical to the standard in the second and third year under-graduate courses in the universities. For laboratory work the course at the Illinois Institute of Technology makes use of facilities provided by the Underwriters' Laboratories in Chicago; the other universities rely on their own resources for this part of the instruction.

The course on Fire Technology and Administration offered in the Connecticut Evening Technical Institute was devised mainly to provide training on a post-secondary level for firemen and fire company officers. The programme was developed in co-operation with the Connecticut Fire Chief's Association and Fire Marshal's Association, and other fire and firemen's organizations in the state. This course was generally of a more severely practical type than the university courses mentioned above and included a substantial element of instruction on Fire Service and Fire Department Leadership and Administration. Details of this course are given in Appendix III.

NUMBERS TAKING THE COURSES

The total number of students taking the full-time university under-graduate courses was about 150. Not all these students would generally be expected to graduate, and it was the experience of one of the universities that about two-thirds of the students enrolled did not finish the course. Of those students that had graduated approximately 70 per cent found employment in insurance offices, and most of the remainder joined governmental agencies including the Federal Government. A small percentage found direct employment in private industry. There was no indication that any of the graduates had found direct employment in a fire service department.

The area of employment for graduates from the universities was greatly influenced by the fact that many students received scholarships from insurance organizations and these students were obliged to work for insurance organizations following graduation. There was evidence, however, of a greater demand from industry for fire protection graduates than might be indicated by the above figures, and one of the universities stated that they had not been able to satisfy the industrial demand for fire protection graduates. However, many of the graduates that first worked for insurance organizations took up employment later with industrial corporations and various governmental agencies.

It was stated that 141 students were enrolled for the Fire Technology and Administration Course of the State of Connecticut and 36 of these had undertaken to study the full five-year course. The course was initiated in 1964 so it was not possible as yet to say how many would complete it. Many of the students were described as preparing themselves for advancement in their respective departments or thinking of the future when on retirement from the fire service they might obtain employment in a fire insurance industry or as fire prevention inspectors.

DISCUSSION

The experience in the United States in providing graduate instruction in fire protection may be described as useful and significant but not yet very substantial and certainly not comprehensive. It is directed to individual parts of the fire protection world rather than providing an output of trained men who could enter into any major fire activity. The universities provide approximately forty graduates per annum and nearly all these enter in the first instance into insurance activities and very few indeed into fire brigades. However, an effort is beginning to be made mainly by technical colleges, for example in Connecticut and New York to provide instruction up to graduate level which is more specifically designed for fire brigade personnel, but these have not produced any graduates up to now. There does not seem to be much support as yet for a comprehensive fire under-graduate course designed to fill the needs of all the major organizations that need trained staff. This may possibly be due to a specific lack of demand for such staff from local fire departments; on the other hand it may also be due to an inherent irreconcilability of the different requirements.

The subject matter that is covered in the graduate courses is very wide and ranges from techniques of training men and the administration of fire departments to the programming of digital computers. Probably all subjects that one could specify as being worthy of consideration in a Fire Protection Course are present in one or other of the four courses outlined in the Appendices. Possible exceptions are statistical methods and operational research. The latter is only now beginning to find application in fire protection planning and the operation of fire departments, but perhaps in 15 years it may be used extensively in all organisations that deal with fire. The survey of these courses described in this note has suggested that a common criticism may be applicable to all the courses, particularly those in the universities. They appear to consist of special

programmes on Fire Hazards, Fire Engineering, Fire Protection, etc. i.e. the engineering and technology of assessing and handling fire problems, added bodily to programmes taken from other curricula on science and engineering subjects, but studies on the science of fire processes that would link the two major parts of the course appear to be lacking. It would also appear possible that graduates could pass through any of the courses without learning much about fuels and combustion processes generally. Such information could well be the basis of future advances in fire protection methods. Perhaps it would also be fair to say that the instruction in Mathematics and in Engineering given in the American courses is not as wide as that laid down in the syllabus for the Council of Engineering Institution's examinations (1).

It is difficult to draw from American experience any useful conclusions which could be applicable in this country. The American university courses on Fire Protection Engineering rely very heavily for support on insurance organizations, but, it is unlikely that they supply more than a fraction of the trained staff requirements of these organizations. In this country the insurance world maintain their own establishments for training although there are the beginnings of higher education in insurance generally at British universities (2). Although there has been some evidence for a demand for trained fire technologists outside the insurance world in the United States, this does not seem to have been sufficient to provide significant support at least for the university courses. Nevertheless, it should be recognized that the effort which American universities have put into the development of courses on Fire Technology, and in sustaining a useful output of graduates, has gone a long way towards training a versatile fire technologist capable of being employed in different sectors of the fire industry. The formulation of a university degree course in Fire Technology in this country could in many ways usefully follow the American precedent.

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REFERENCES

(1) The Council's examination. Part 1. Syllabuses and specimen papers. Council of Engineering Institutions Education and Training Statement No. 1. London, 1966.

(2) Developing insurers. Economist, 1966, 220 (6413) xviii.

APPENDIX I

UNDERGRADUATE COURSES ON FIRE PROTECTION IN AMERICAN UNIVERSITIES

(a) UNIVERSITY OF MARYLAND

Freshman Year

Composition and American Literature; Elementary Analysis; Calculus I; General Chemistry; Engineering Graphics; Introductory Mechanics; Basic Air Science; Physical Activities.

Sophomore Year

American Government; (Sociology of American Life or Introduction to Psychology or Philosophy of Modern Man); Calculus II, III; General Physics; Mechanics of Material; Dynamics; Thermodynamics; Physical Activities.

Junior Year

Composition and World Literature; Materials Science; Property Insurance; Fundamentals of Economics; Fluid Mechanics; Essentials of Fire Protection; Fire Protection Organization; Installations and Equipment; Insurance Rating and Schedules; Approved Electives.

Senior Year

History of American Civilization; Water Supply; Environmental Consideration of Nuclear Engineering; Industrial Safety Education; Fire Protection Fluids and Systems; Fire Analysis; Special Hazards and Problems; Technical Projects; Approved Technical Electives.

(b) OKLAHOMA STATE UNIVERSITY

First Year

Technical Drawing; Personal and Occupational Guidance; Fire Extinguishing and Alarm Systems; Fire Hazards and Causes; General Chemistry; Basic Writing Skills; Principles of Fire Inspection; Technical Mathematics; Fire Protection; Fire Codes and Standards; Industrial Fire Hazards; General Chemistry; Composition.

Second Year

Essentials of Electricity; Automatic Sprinklers; Fire Protection Hydraulics; General Insurance; Industrial Safety Engineering; Challenges in American Democratic Life; Applied Physics; American Industrial Development; Fire Inspection Practices; Water Supply Analysis; Electrical Codes and Inspection; Property and Casualty Insurance; Essentials of Public Speaking.

(c) ILLINOIS INSTITUTE OF TECHNOLOGY

First and Second Semesters

Calculus and Analytic Geometry I; Mechanics; General Inorganic Chemistry; Reading; Writing and Thinking I; Introduction to Graphics; Physical Education; Engineering and Science Orientation; Calculus and Analytic Geometry II; Heat and Wave Motion; General Inorganic Chemistry; Reading, Writing and Thinking II; Descriptive Geometry; Physical Education.

Third and Fourth Semesters

Analytic and Calculus; Electricity and Magnetism; Principles of Economics; Physical Chemistry (Thermodynamics); Fire Insurance Schedule Rating; Differential Equations; Atomic Physics; Statics and Dynamics; Principles of Economics; Fire Insurance Schedule Rating.

Fifth and Sixth Semesters

Fire Protection Engineering Laboratory; Property Insurance; Structural Fire Protection; Fluid Mechanics; Strength of Materials; Organic Chemistry; Programming for Digital Computers; Fire Protection Engineering Laboratory; Casualty Insurance; Public Fire Protection; Electrical Circuit Analysis; Electronic Processes in Materials; Heat and Mass Transfer; American Constitutional System.

Seventh and Eighth Semesters

Fire Protection Engineering Laboratory; Industrial Hazard Control; Fire Protection Extinguishing and Detection Systems; Engineering Electronics; Industrial Safety; Liberal Arts Elective; Fire Protection Engineering Laboratory; Electrical Hazard Control; Industrial Hazard Control; Fire Protection Extinguishing and Detecting Systems; Liberal Arts Elective; Humanities Elective; Industrial Safety.

APPENDIX II

DETAILS OF FIRE PROTECTION AND SAFETY ENGINEERING COURSE
AT THE ILLINOIS INSTITUTE OF TECHNOLOGY

THIRD AND FOURTH SEMESTERS (2nd YEAR)

MATHEMATICS

Calculus and Analytic Geometry III

Polar coordinates; solid analytic geometry; partial differentiation; multiple integrals; series and expansion of functions.

Differential Equations

Fourier series; the classical treatment of the common types of ordinary differential equations; applications.

PHYSICAL SCIENCES

Electricity and Magnetism

Charge, electric field and potential, Gauss' Law, electric properties of matter, magnetic field, Ampere's Law, Faraday's Law, inductance, magnetic properties of matter, LRC circuits, electromagnetic oscillations and waves, light as an electromagnetic wave.

Atomic Physics

Electrons, special theory of relativity, radiation quanta, photoelectric and Compton effects; Rutherford scattering. Bohr atom and spectra; elementary wave mechanics and the periodic table; structure of solids, electrons in metals; semi-conductors; radioactivity, nuclear reactions, recently discovered particles.

BUSINESS AND ECONOMICS

Principles of Economics, I, II

Fundamental principles and their application to modern society; production, prices, exchange, distribution of income, labour problems, money and banking, international trade, business cycles, income fluctuations, role of government.

ENGINEERING SCIENCE

Physical Chemistry (Thermodynamics)

Introduction to thermodynamics, including the first, second and third laws.

Statics and Dynamics

Equilibrium concepts. Statics of a particle. Statics of a system of particles and rigid bodies. Friction. Kinematics of a particle. Kinematics of a rigid body. Euler angles. Motion in moving coordinates. Dynamics of a particle. Work, kinetic energy and potential energy. Dynamics of a system of particles. Mass center motion. Impulse. Linear and angular momentum. Moments of inertia. Dynamics of rigid bodies. Euler's equations of motion. Work and energy. Plane motion of a rigid body. Vibrations.

FIRE PROTECTION ENGINEERING

Fire Insurance Rating

Modern methods of fire hazard analysis and the procedure involved in the computation of fire insurance rates. The Analytic System for the Measurement of Relative Fire Hazard and its application to a variety of buildings and occupancies.

FIFTH AND SIXTH SEMESTERS (3rd YEAR)

FIRE PROTECTION ENGINEERING

Fire Protection Engineering Laboratory

The theory and practice of hydraulic measurement, examinations, and test of first-aid fire-extinguishing appliances, and observation of tests, retardant materials and devices.

Property Insurance Principles and Practices

The history of insurance, economic aspects of risk and risk bearing; the standard fire, marine, automobile and casualty contracts, workmen's compensation laws and insurance; financial analysis of insurance carriers.

Public Fire Protection

Various types of public water systems with emphasis on fire protection design requirements. Fire department organization and operations including apparatus design and fire service hydraulics. Design and operation of municipal fire alarm systems.

Structural Fire Protection

Various types of construction assemblies and building materials with emphasis on life safety design, fire-resistance, flame spread and fire protection engineering principles. Building codes and fire conflagration factors.

ENGINEERING SCIENCE

Fluid Mechanics

Basic properties of fluids. Fluid statics. Basic concepts for fluids in motion; Lagrangian and Eulerian viewpoints, substantial derivative, streamlines, etc. Continuity, energy and linear momentum equations in integral and differential forms. Integration of equations for one dimensional flows and application to problems. Incompressible viscous flow; Navier-Stokes equations, parallel flow, pipe flow and the Moody diagram. Introduction to laminar and turbulent boundary layers. One-dimensional compressible flow; supersonic and subsonic flow, nozzle flow.

Strength of Materials

Concepts of stress and strain. Plane states of stress and strain at a point and stress-strain relations. The concept of strain energy and elementary energy methods. Stress concentrations; mechanical properties; theories of failure; significance in design. Approximate analysis of elementary stress distributions and deformations; axial loading, shear and bending moment diagrams, elementary bending theory, symmetric bending, torsion of circular shafts. Introduction to statically indeterminate problems. The continuous beam. Three moment equation. Introduction to buckling of columns.

Electric Circuit Analysis I

Forced and natural response of electric circuits. Applications of Laplace Transform methods and Fourier Series to electric circuit analysis.

Electronic Processes in Materials

Elements of statistical-quantum mechanics applied to free-electron and band theory of solids, semi-conductor theory, and magnetic optical, and electrical properties of conductors and nonconductors.

Heat and Mass Transfer

Basic laws of mass and heat transfer. Similarity relations and analogies. Steady state and transient heat conduction, including thermal sources. Free and forced convection; dimensional analysis and boundary layer concepts. Fundamentals of radiation. Combined radiation, conduction and convection. Extended surfaces; heat exchangers. Analytical, numerical and graphical solutions are presented. Electrical analogues.

CHEMISTRY

Organic Chemistry

General principles of synthetic and theoretical organic chemistry.

MATHEMATICS

Programming for Digital Computers

Theory of large-scale digital computers; programming; numerical methods; applications.

The American Constitutional System

Structure and operation of democratic government. American democratic theories. Political processes in elections, legislation, and administration. The constitutional framework of American government, and judicial review. Introductory course for students not majoring in the social sciences.

SEVENTH AND EIGHTH SEMESTERS (4th YEAR)

FIRE PROTECTION ENGINEERING

Fire Protection Engineering Laboratory

Systematic study of various types of automatic extinguishing devices and systems emphasizing mechanical and hydraulic principles involved.

Industrial Hazard Control

Flammable liquids, gases, combustible solids, dusts, chemicals and explosives with special emphasis on their industrial applications. Analysis of various types of equipment and processes in particular industries with emphasis on fire hazards involved.

Electrical Hazard Control

Static electricity and electricity for power and lighting as bearing upon the fire problem, including theory and practice of design and installation of equipment and measures for control of the hazard.

Fire Extinguishing and Detection Systems

Design and application of various types of automatic extinguishing systems including automatic sprinklers, water spray, foam, carbon dioxide and dry chemical systems. Theory and design of various types of heat and smoke detection systems and private signalling systems. Fire pumps, extinguishers and standpipe systems.

ENGINEERING SCIENCE

Engineering Electronics

Vacuum tubes. Physical principles of semi-conductor diodes and transistors. Gaseous conduction, gas tubes, photoelectric cells. Application of tubes and transistors to basic electronic circuits.

Safety Engineering

Industrial Safety I

Fundamental approach to a safe working environment: inspection, investigation, mechanical guarding, maintenance, consideration in design and specifications. Control of exposure to occupational disease; motor vehicle accident prevention.

Industrial Safety II

Industrial safety programmes; safety promotion by industry; the insurance carrier and public agencies. Exposures to occupational disease; preventive measures. Organization and operation of the motor vehicle accident prevention activity.

Liberal Arts Elective

The College of Liberal Arts of Illinois Institute of Technology is composed of five departments: Biology; Business and Economics; Language, Literature, and Philosophy; Political and Social Science; Psychology and Education. These departments offer curricula that lead to baccalaureate and graduate degrees in many disciplines. The College also offers a programme leading to the degree of Bachelor of Science in Liberal Arts that is appropriate for students interested in those disciplines in which a specific degree is not granted. This programme is especially suited to students whose particular interests may require a more broadly based course of study cutting across several disciplines.

APPENDIX III

FIRE TECHNOLOGY AND ADMINISTRATION (EVENING COURSE) AT HARTFORD CITY TECHNICAL INSTITUTE, CONNECTICUT

FIRST YEAR

Introduction to Fire Technology I & II

An introductory course reviewing the fire problems and broadly touching various phases of the fire technology field, includes characteristics and behaviour of fire, hazardous properties of materials, fire protection equipment, extinguishing agents, and building construction. The National Fire Protection Association Fire Protection Handbook is used as the text.

Fire Service Organization and Management

An introductory course giving principles of organization of small, medium-sized, and large fire departments, state and county fire organizations, building the organization, physical facilities, personnel, administrative functions, records, evaluation methods.

Technical Mathematics I & II

A general review of fundamental algebraic operations. It includes a study of fractions and fractional equations, factoring, exponents, radicals linear equations, engineering notation and graphical representation of equations.

Fire Science I (Physics I)

A short study of physical units and measurements, mechanics vector quantities, forces in equilibrium, uniformly accelerated linear motion, friction, work and power, energy forms and transformations, torque, moment of inertia. Pre-requisite - Technical Mathematics II.

SECOND YEAR

Fire Service Leadership and Psychology

Principles of psychology as applied to the fire service, why men work, incentives, building organizational teams, introducing changes, problems of discipline, job planning and job management.

Building Construction I

Types of building construction as they relate to fire problems - frame, woodjoisted masonry, non-combustible, fire-resistive; simple blueprint reading and free-hand sketching; fire-resistance and flame spread ratings. Prerequisite-Fire Science I.

Building Construction II

A continuation of Building Construction I with emphasis on building components. Fire walls and partitions, protection of openings by fire doors and fire windows, heating, air-conditioning, and electrical systems, standpipes, building codes and other applicable standards. Use of Sanborn Maps. Prerequisite-Building Construction I.

Fire Science II (Physics II)

Heat and motion with emphasis on temperature measuring devices, thermal expansion, perfect gas laws, specific heat, changes of state, thermal conduction and radiation, heat balances, electric energy - heat relation. Prerequisite-Technical Mathematics II.

Fire Science III (General Chemistry I)

A study of the fundamental principles of general chemistry, including the common elements, equations and types of chemical reactions, particularly as they apply to fire problems.

Fire Science IV (General Chemistry II)

A continuation of Fire Science III which includes a study of the speed of chemical reactions, chemical equilibrium and oxidation and reduction. Prerequisite-Fire Science III.

THIRD YEAR

Fundamentals of Electricity

Fundamental principles of electricity and magnetism, Ohms Law, DC circuits, Kirchoff's Law, batteries, D.C. instruments, A.C. electricity, inductance, capacitance, transformers, generators, Prerequisite-Technical Mathematics II.

Industrial Processes and Hazards

The forming, fabrication, treatment and inspection processes for metals and plastics and their associated fire and explosion hazards, metal casting, heat treatment, powder metallurgy, combustible metals, cutting and welding, plastic molding. Prerequisite-Fire Science II and IV.

Hydraulic Technology

Basic properties of fluids, pressure, forces, centre of pressure, interpretation of readings from various kinds of manometers, pressure gauges, and hydrostatic devices, fluids in motion, head calculations, pumping problems, friction losses, cavitation, velocity of flow, use of pitot and venturi meters, viscosity, discharge from weirs, orifice meters. Prerequisite-Fire Science I.

Technical Report Writing

The fundamentals of writing reports with emphasis on the use of words, sentence structure, punctuation and the paragraph. Unity, brevity, coherence and clarity are stressed.

Oral Communications

Principles of delivery, improving voice quality, developing vocal variety, analyzing the occasion, sources of material, extemporaneous speaking, writing and presentation of short speeches.

Techniques of Training

Psychology of learning, four-step method, lesson planning, instruction techniques, training aids, tests, workbooks, training objectives and curriculum development, conducting conferences and meeting.

FOURTH YEAR

Water Supply and Sprinkler Systems

Distribution systems, tanks, standpipes, hydrants, National Board of Fire Underwriters' standards, sprinkler systems of various types. Prerequisite-Hydraulic Technology.

Fire Prevention and Inspection

Organizing for fire prevention and inspection, fire prevention campaigns, training inspectors, public relations in inspection work, methods of inspection, co-ordination with other governmental agencies.

Fire Insurance Principles

The fundamentals of fire insurance, rating methods, loss records, municipal gradings and underwriters standard grading schedule.

Economics

A study of the fundamental principles of economics, laws of supply and demand and principles bearing upon production, exchange, distribution and consumption.

Fire Department Financial Administration

Budget items and preparation of budgets, justifying budgets, financial statements, cost accounting, taxation, loans, interest, municipal finance, depreciation, reserve funds, accounts and audits.

FIFTH YEAR

Fire Department Planning

Analysis of fire department needs, distribution of companies, selection and procurement of land, planning fire stations, personnel requirements, shifts, vacation plans, equipment and maintenance requirements.

Fire Investigation

Determination of causes of accidental and incendiary fires, fire losses and loss records, points of origin, location and preservation of physical evidence, scientific aids to investigation. Motives and methods for fire setting, investigative methods. Prerequisites-Fire Science II and Fire Science IV.

Legal Problems of the Fire Service

Laws governing the organization and operation of fire departments, liability, forest fire-fighting, mutual aid, arson, fire prevention, building construction, labour and health laws affecting the fire service.

Fire Department Specifications and Purchasing

Preparation of specifications for apparatus, hose and minor equipment, fire station specifications, bid procedures, contracts, price structures, discounts, trials, guarantees, quality control and inspection.

Fire-Fighting Strategy

Predicting and planning for fires, combined operations, mutual aid, disaster planning, problems in unusual fire operations.

Electives

Public Relations for Fire Departments

Meaning and importance of public relations, communications media, press, radio and TV releases, publicity, annual and special reports.

Fire Alarm and Communications System

Fundamentals of municipal, central station, proprietary and local alarm systems, heat, flame and smoke detectors, telephone, teletype, and radio systems. Prerequisite-Fundamentals of Electricity.

Radiation Hazards and Instrumentation

Elementary atomic theory, ionization, x-rays, nuclear fission and fusion, radiation detection equipment, peacetime uses of radioactive materials, control of hazards. Prerequisite-Fire Science IV.

Mutual Aid Seminar

Current problems in mutual aid, pacts and agreements, organization of county mutual aid plans, local mutual aid plans with private and governmental agency fire departments, organizing control centres, communications, test exercises, liability, dispatching, running cards, relations with Civil Defense and other government agencies.