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# Courses Available in Photogrammetry

Academic degrees are offered at eleven  
universities in the United States.

*ABSTRACT: The course descriptions, the equipment and laboratory facilities, and the computer facilities are listed for eleven universities in the United States offering a degree program in photogrammetry. These are the results of a poll conducted in October 1965 by the Education Committee of the American Society of Photogrammetry.*

## INTRODUCTION

THE AMERICAN SOCIETY OF PHOTOGRAMMETRY has reported periodically in the past on the general status of photogrammetric education in the United States<sup>1,2,3,4</sup>.

These reports have given summaries of the photogrammetric educational programs in the U. S., and have not attempted to emphasize the actual courses and their contents. One of the tasks of the education committee has been to compile this information in one paper.

The following has been compiled from eleven schools in the United States offering degree programs with a major in photogrammetry.<sup>1</sup> The purpose of this report is to inform all interested persons, whether they be

prospective students, members of ASP, or the general public, as to what is available in formal course work in photogrammetry in these schools as of January 1, 1966.

All eleven schools have programs leading to the Master's degree, and California, Cornell, Illinois, Ohio State and Wisconsin presently offer studies leading to the doctorate degree. Syracuse will offer a program leading to the doctorate degree beginning in 1966.

Table 1 gives a summary of the eleven schools reporting, and the addresses of the persons to contact for further information.

It should be noted that course contents, equipment, and computing facilities change continually. It is intended that reports of this

TABLE 1  
SCHOOLS OFFERING A MAJOR PROGRAM IN PHOTOGRAMMETRY

| College                               | Further Information Available From  |
|---------------------------------------|---|
| California, University of (Berkeley)  | Prof. F. H. Moffitt, C. E. Dept., Berkeley, Calif. 94720  |
| Cornell University                    | Prof. A. J. McNair, School of Civil Engineering, Ithaca, N. Y. 14850  |
| Georgia Institute of Technology       | Prof. J. A. Eichler, C. E. Dept., Atlanta, Ga. 30332  |
| Georgia, University of                | Prof. M. Prunty, Jr., Geography Dept., Athens, Ga. 30602  |
| Illinois, University of               | Prof. H. M. Karara, C. E. Dept., Urbana, Ill. 61803   |
| Missouri School of Mines & Metallurgy | Prof. E. W. Carlton, C. E. Dept., Rolla, Mo. 65401  |
| Ohio State University                 | Prof. S. K. Ghosh, Dept. of Geodetic Sciences, Columbus, Ohio 43210   |
| Purdue University                     | Prof. E. M. Mikhail (Photogrammetry), C. E. Dept.,<br>Prof. R. D. Miles (Photointerpretation), W. Lafayette, Ind. 47906 |
| Syracuse University                   | Prof. D. C. Merchant, C. E. Dept., Syracuse, N. Y. 13210  |
| Texas, University of                  | Prof. R. D. Turpin, C. E. Dept., Austin, Texas 78712  |
| Wisconsin, University of              | Prof. E. C. Wagner, C. E. Dept., Madison, Wis. 53706  |

nature occur often enough to keep interested persons informed.

If this information is viewed from a prospective student's standpoint then it is highly recommended that you contact the persons listed in Table 1 for further information. In several cases the individual schools have outlined their programs to considerable length in brochures which are free for the asking.

I would like to thank Professor Dean C. Merchant, who has been very helpful in reviewing this article. I also acknowledge and thank the men listed in Table 1 for their cooperation in forwarding the information for their respective schools.

### University of California, Civil Engineering Berkeley, California

COURSE DESCRIPTIONS—(Semester Hours)  
CE-101 ELEMENTARY PHOTOGRAMMETRY (3 units)

Nature of problems handled by photogrammetric methods; precision cameras and their calibration; comparator measurements; geometry of photograph; ground control for mapping; flight planning; stereoscopy and stereoscopic parallax; geometry of overlapping vertical photographs; radial line plot; mosaics; oblique photography and applications; introduction to stereoscopic plotting instruments. Two lectures and one 3-hour lab per week.

CE-107 AIRPHOTO ANALYSIS AND INTERPRETATION (3 units)

Elements of a photograph for reading, analysis and interpretation. Analysis applied to soils, slopes, geological forms and structures, selection of materials for engineering construction. Elementary planimetric mapping from aerial photos; stereoscopy; mosaic construction; annotations and overlays. Two lectures and one 3-hour lab per week.

FORESTRY 132 FOREST PHOTOGRAMMETRY (3 units)

Construction of planimetric and topographic maps from vertical and oblique aerial photographs; the use of aerial photographs in mapping vegetation types and estimating timber volumes and in control of forest fires; construction of mosaics. Two lectures and one 3-hour lab per week.

### BIBLIOGRAPHY

1. Merchant, D. C., 1963, "A Survey of Courses Offered in Photogrammetry", *PHOTOGRAMMETRIC ENGINEERING*, Vol. XXIX, No. 6, (November), 960.
2. Brinker, R. C., 1951, "A Study of the Status of Photogrammetry in the Engineering Schools of the United States and Canada", *PHOTOGRAMMETRIC ENGINEERING*, Vol. XVII, No. 3 (June) 431.
3. McEntyre, J. G., 1958, "The Status of Photogrammetry in the Educational Institutions of the United States," *PHOTOGRAMMETRIC ENGINEERING*, Vol. XXIV, No. 2 (April) 246.
4. Turpin, R. D., 1960, "Some Trends in Photogrammetric Education in the United States", *PHOTOGRAMMETRIC ENGINEERING*, Vol. XXVI, No. 1 (March) 127.

GEOLOGY 109 TOPOGRAPHICAL PHOTO INTERPRETATION (3 units)

The identification and classification of topographical formations, slopes, gradients, patterns, on aerial photographs; the solution of selected problems in photogrammetry.

CE-198, CE-298 GROUP STUDY IN SELECTED SUBJECTS (1 to 5 units)

Analytic photogrammetry; theory and design of stereoscopic plotting instruments; analysis of systematic and random error propagation in photogrammetric system; stereotriangulation and adjustment; terrestrial photogrammetry applied to rubber membrane analogies, deformation measurements, hydraulics, waves, architecture; photogrammetric optics; camera calibration and lens distortion measurement. Lectures vary from one to five hours per week. Lab work varies from 3 to 9 hours per week.

CE-199, CE-299 INDIVIDUAL STUDY IN SELECTED SUBJECTS (1 to 5 units)

Usually consists of unique application of photogrammetry or photo interpretation to a problem in the general engineering area.

### PHOTOGRAMMETRIC EQUIPMENT AND LABORATORY FACILITIES

CIVIL ENGINEERING

- 1—Multiplex Auxiliary Unit, 3 projectors
- 1—Wild A5 Autograph with reduction printer and Corr. plates for Metrogon and "distortion-free" photography

- 1—Balplex 760 Plotter with centering device, 2 projectors
- 1—Zeiss C4 Stereoplanigraph with "distortion-free" hypergon lenses
- 1—T30 Wild Phototheodolite
- 1—Rolleiflex camera with wide angle lens and plate adaptor back
- 2—K25 Aerial Cameras modified for finite focus and synchronous exposures
- 1—Universal reduction printer
- 11—12-inch micro rules
- 6—12-inch Gurley Rapid Comparators
- 1—Reed Focalmatic Desk projector
- 1—Old Delft scanning stereoscope
- 6—Wild ST3 mirror stereoscopes with parallax bars
- 1—Vertical Sketchmaster
- 1—set Mechanical Triangulators
- 1—10 in. by 10 in. contact printer
- 8—Abrams Contour Finder

- 6—Stereocomparagraphs
- 1—Kail Radial Planimetric Plotter
- Misc. stereoscopes, drafting equipment

## FORESTRY

- 1—KEK plotter
- Misc. stereoscopes, drafting equipment

## GEOGRAPHY

- 1—KEK plotter
- Misc. stereoscopes, drafting equipment

## COMPUTING CENTER FACILITIES

IBM 7090 System, staffed by operators and programmers, but operates on an open shop basis for individual staff and graduate students to develop programs as needed by them. A computer program library service is available which is kept up to date.

IBM 1620, programming by students, operation of computer by regular staff member.

**Cornell University, School of Civil Engineering  
Surveying Department, Ithaca, New York**

## COURSE DESCRIPTIONS—(Semester Hours)

CE-2121 ELEMENTS OF PHOTOGRAMMETRY  
Credit 3 hours. Fall.

Principles and practice of terrestrial and aerial photogrammetric mapping, including planning flights, control surveys, uncontrolled mosaics, radial-line control, simple stereo-plotting instruments, parallax distortions, graphical tilt determination, trimetrogen charting, and economics. A Balplex projection stereoplotter with three projectors is available for use.

CE-2122 ADVANCED PHOTOGRAMMETRY  
Credit 3 hours. Spring.

Lectures, reading, and laboratory work. An advanced study of photogrammetric principles including controlled mosaics, rectification, graphical, mechanical, and analytical, space orientation. Readings and reports from current technical literature. The principles of many photogrammetric plotters are studied together with the economic relation of these instruments to density of field control, office methods, and personnel. The Balplex plotter is available for study and use.

CE-2123 ANALYTIC AEROTRIANGULATION  
Credit 3 hours.

Analysis, theories, and computation of stereostrip triangulation by direction cosines, vector, and matrix methods. Coplanarity and

colinearity equations for relative orientation and absolute orientation. Stereogram assemblage and coordinate transformation of strip and block coordinates. Cantilever extension and general bridging solutions. Propagation of errors.

## CE-2141 PROJECT: ANALYTICAL PHOTOGRAMMETRY

Credit 3 hours. Graduate students.

Analysis of such analytical aerotriangulation as: space resection and orientation methods; co-linearity relationships; co-planarity relationships; vector representations; matrix representations; assembly of stereopairs, triplets, strips, and blocks; two- and three-dimensional coordinate transformations of linear-, second-, and higher-degree, error propagation.

Special short courses offered at irregular intervals. No academic credit. Emphasis depends upon particular demands and varies from 100% airphoto interpretation to 100% advanced photogrammetry.

## CE-2142 GEODETIC OR PHOTOGRAMMETRIC ENGINEERING RESEARCH

On demand. Prerequisites will depend upon the area of studies to be pursued. Special problems in error analysis, geodesy, and photogrammetry as may be arranged.

CE-2143 SEMINAR IN GEODESY OR PHOTOGRAMMETRY

Credit 1-6 hours.

On demand. Open to specially selected seniors or graduate students. Abstraction and discussion of technical papers and publications in the geodetic or photogrammetric field.

CE-2621 ANALYSES AND INTERPRETATION OF AERIAL PHOTOGRAPHS

Preregistration required. Credit 3 hours. Fall-Spring 2 lectures, 1 laboratory.

A study of the soil and rock areas of the United States and the patterns present in aerial photographs. Fundamental elements of soil patterns are analyzed to permit determination of soil texture, type of bedrock, and drainage properties. Field training in selected test areas.

CE-2622 ADVANCED INTERPRETATION OF AERIAL PHOTOGRAPHS

Preregistration required. Credit 3 hours. On demand.

Organization of course depends upon fields of interest. Special problems; four each on ground water, engineering projects, agricultural soils mapping, irrigation and geology.

CE-2631 PHYSICAL ENVIRONMENT EVALUATION

Credit 3 hours. On demand.

2 lectures, 1 laboratory. Intended for graduate students or upperclassmen in engineering and planning. Permission of the instructor.

A study of physical environment factors affecting engineering and planning decisions and the evaluation methods of these factors. Physical factors include the climate, soil and rock conditions, and water sources in different parts of the world. Evaluation methods include air and ground reconnaissance, interpretation of meteorological, topographic, geological, and soil maps, aerial photography, engineering data, and subsurface exploration records.

CE-2632 ADVANCED PHYSICAL ENVIRONMENT

Credit 3 hours. On demand.

Closely related advanced courses: 2111 Elementary Geodesy, 2112 Geophysical Geodesy,

2113 Geodetic Control Surveys, 2115 Advanced Engineering Measurements, 2119 Map Projections, 2131 Land Surveying, 2132 Cartography, 2133 Engineering Surveys.

PHOTOGRAMMETRIC EQUIPMENT AND LABORATORY FACILITIES

- 1—Balplex—3 projectors
- 1—Fairchild Stereocomparagraph
- 3—Abrams Height Finders
- 50—Stereoscopes (mirror and lens types)
  - 1—Old Delft Scanning Stereoscope
  - 1—Set Abrams Lazy Daisy Radial Triangulator (40 photo)
  - 1—Slot Cutter
  - 1—Kail Radial Planimetric Plotter
  - 1—Abrams Oblique Sketchmaster
  - 1—Abrams Vertical Sketchmaster
- 5—24×30" Fluorescent light tables
- 1—Wild Trilateration Computer, TC1

Special control photography of campus at 5 scales varying from 1:3000 to 1:20,000. World-wide air photo coverage in photo interpretation Laboratory. Photos classified according to location, drainage pattern geology, soils type, and land form

Photographic dark room and laboratory

By arrangement facilities of the Photo Science Department are available for use which include special printing and projection equipment.

COMPUTER CENTER FACILITIES

A fully staffed and operating Cornell Computing Center is available for electronic digital computing of any size or type. Special analog computer laboratories also may be used. Digital computer equipment includes:

Control Data Corporation 1604

Control Data Corporation 160A

Control Data Corporation X-Y Plotter 165

Collating, tabulating, high-speed printing, and all other ancillary equipment necessary for the operation of a large modern computing center are available. An individual key punch machine is located in the same building as the photogrammetry laboratories. Students, after a brief training period with a demonstrated competence may make arrangements to operate the computers on their own problems. All computing is done for or by students at no charge.

**Georgia Institute of Technology, School of Civil Engineering  
Atlanta, Georgia**

**COURSE DESCRIPTIONS—(Quarter Hours)**  
CE-438 ELEMENTARY AERIAL PHOTOGRAMMETRY

History and development of photogrammetry. Fundamental principles. Aerial cameras. Photo reading. Principles of stereoscopy and stereoscopic instruments; radial line plotting; topographic mapping by Balplex and Plotter. Parallax measurement and formulas.

CE-454 PHOTOGRAMMETRIC AND SURVEYING INSTRUMENTS ADJUSTMENT AND USE

CE-601 ADVANCED AERIAL PHOTOGRAMMETRY

Tilt determinations; space resection and intersection. Principal point computations for extension of horizontal control.

CE-602 PHOTOGRAPHIC INTERPRETATION

The identification of soil and rock conditions from aerial photographs; geologic conditions influencing topographic and drainage patterns; the effects of vegetation and land use of photographic tone.

CE-444, CE-445, CE-446 UNDERGRADUATE SPECIAL PROBLEMS

CE-704, CE-705, CE-706 GRADUATE SPECIAL PROBLEMS

The special problems in both the graduate and undergraduate level are of the analytical type. They are concerned with the new theories and applications of photogrammetry and they allow the student to pursue problems and ideas in which he has a special interest.

PHOTOGRAMMETRIC EQUIPMENT AND  
LABORATORY FACILITIES

- 1—Balplex Plotter
- 7—Sketchmasters
- 5—Stereocomparagraphs
- 15—Mirror Stereoscopes
- 4—Parallax Bars
- 8—Desk Calculators
- 2—Key punches for computer

COMPUTING CENTER FACILITIES

- Burroughs 220
- Burroughs B-5500

The computing center is available at all times for both graduate and undergraduate students.

**The University of Georgia, The George Foster Peabody School of  
Forestry, Athens Georgia**

**COURSE DESCRIPTIONS—(Quarter Hours)**

420 USE AND INTERPRETATION OF AERIAL PHOTOGRAPHS

5 laboratory periods.

Theory and procedures in use of aerial photos for mapping, planning, terrain and contour identification, forest and vegetation identification. Procedures in correction of photo errors, for preparation of base-maps. Training in use of standard photogrammetric instruments, and in planning of photo-reconnaissance of sample areas.

422 ADVANCED PHOTOGRAMMETRY LABORATORY

5 laboratory periods.

Laboratory instruction on individualized photogrammetric problems related to the major interests of the students. Mastery of advanced photogrammetric instruments.

PHOTOGRAMMETRIC EQUIPMENT AND  
LABORATORY FACILITIES

- 50—lens stereoscopes
- 10—mirror stereoscopes
- 10—vertical sketchmasters
- 6—oblique sketchmasters
- 4—parallax bars
- 10—stereometers
- 1—Salzman overhead projector
- 1—Kelsh plotter
- Light tables
- Drafting equipment and map reproduction equipment (ozalid)
- 3—electric calculators

2 air conditioned labs in new building, each seating 20 students at individual drafting tables. In addition, a research lab for the Kelsh plotter and other research equipment.

COMPUTING CENTER FACILITIES

- 1—IBM 7094
- 1—IBM 7040
- 1—IBM 1401

Plus conventional tabulating, and collating equipment.

University of Illinois, Department of Civil Engineering  
Urbana, Illinois

COURSE DESCRIPTIONS—(Semester Hours

CE-297 SPECIAL PROBLEMS

Undergraduate Credit: up to 4 sem. hours

Individual investigations or studies of any phase of civil engineering selected by the undergraduate student and approved by the department.

CE-299 THESIS

Undergraduate. Credit: up to 3 sem. hours

Investigation or design. May be substituted for certain technical subjects in any of the majors in the senior year.

CE-302 PHOTOGRAMMETRIC ENGINEERING

Credit: 3 sem. hours for undergraduates and  $\frac{1}{2}$  unit for graduates.

A study of metrical photography in civil engineering practice; characteristics and interpretation of aerial and terrestrial photographs; stereoscopic compilation of maps from photographs; mosaics; economics of photogrammetry.

CE-307 TERRESTRIAL PHOTOGRAMMETRY

Credit: 3 sem. hours for undergraduates and  $\frac{1}{2}$ -1 unit for graduates.

A basic study of metrical photography in other than the aerial case; theory of errors of terrestrial photogrammetry; special cameras and restitution equipment for terrestrial, close-range, micro, and celestial photogrammetry; considerations about planning and design of photogrammetric projects in such cases.

CE-308 PHOTOGRAPHIC INTERPRETATION

Credit: 3 sem. hours for undergraduates and  $\frac{1}{2}$ -1 unit for graduates.

Descriptive interpretation of photographic images with emphasis on interpretation of aerial photographs; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student.

CE-403 PHOTOGRAMMETRY

Credit: 1 grad. unit—equivalent to 4 sem. hours

Study of the principles of stereoscopy and geometrical optics; aerial cameras, their design and calibration; the design, calibration

and operation of stereoscopic plotting machines; mathematics of stereoscopic orientation and model deformations.

CE-404 PHOTOGRAMMETRY

Credit: 1 grad. unit—equivalent to 4 sem. hours.

Theory of errors of stereoscopic photogrammetry; aerotriangulation (spatial and radial), its theory and applications to various civil engineering problems; electronics in photogrammetry.

CE-405 ANALYTICAL PHOTOGRAMMETRY

Credit: 1 grad. unit—equivalent to 4 sem. hours.

A basic study of analytical photogrammetry with emphasis on the recent developments in this field; analytical solutions of single and multiple camera stations; analytical aerotriangulation of photographic strips; and blocks of strips; ballistic and satellite camera applications of analytical photogrammetry.

CE-497 SPECIAL PROBLEMS

Graduate—Credit: up to 4 grad. units—equivalent to 16 sem. hours.

Individual investigations or studies in any phase of civil engineering selected by the student and approved by his advisor and the staff member who will supervise the investigation.

CE-499 THESIS RESEARCH

Credit up to 8 grad. units—equivalent to 32 semester hours.

PHOTOGRAMMETRIC EQUIPMENT AND  
LABORATORY FACILITIES

- 1—Wilk STK-1 Stereocomparator, complete with Wild EK-6—IBM 026 readout system
- 1—Nistri Photocartograph V. Stereoplotter
- 1—Zeiss SEG IV Rectifier
- 1—Zeiss Stereotope with diapositive attachment
- 1—Wild PUG 3 Point Transfer Device
- 1—Set of Zeiss Marking Device, Setting Instrument and 2 Snap Markers
- 2—Zeiss Stereoscope with Dove Prism
- 2—Old Delft Scanning Stereoscope
- 20—Zeiss and Wild Parallax Bar
- 2—Zeiss Sketch Master

Also a collection of minor photogrammetric equipment (Lazy Daisy, Slotted Templet Cutter, Stereocomparagraph, Contour Finder, Pocket Stereoscopes, microrulers, etc.)

#### COMPUTING CENTER FACILITIES

- 1—IBM 7094-1401 electronic data processing system
- 1—IBM 1620 electronic computer
- 1—ILLIAC II electronic computer

### The University of Missouri, School of Mines and Metallurgy, Department of Civil Engineering, Rolla, Missouri

COURSE DESCRIPTIONS—(Semester Hours)  
CE-8 ROUTE, TOPOGRAPHIC AND AERIAL SURVEYING

3 credit hours. Lectures and Laboratory.

The first half of the semester is devoted to the theory and use of simple curves, spirals, superelevations, vertical curves and earth-work computations as applied to railroad and highway surveying. The remainder of the semester covers the elementary principles of photogrammetry with emphasis on map making uses of aerial photographs. Also to be covered are the uses and preparation of topographic maps by transit-stradia and plane table and alidade. Sophomore year, either semester, two lectures and three laboratory hours per week.

CE-305 AERIAL MAPPING

Lectures and laboratory

A continuation of the work started in course CE-8. The principles of photogrammetry are applied with reference to radial line plot and traverse, controlled mosaics, stereoscopic plotting instruments. A topographic map is made from aerial photos, using the stereocomparagraph and contour finder. Tilt determinations are studied to some extent. Senior or graduate, either semester. Credit variable. Elective.

GEOLOGY 254 AIRPHOTO AND MAP INTERPRETATION

2 credit hours. Lectures and Laboratory.

Reading and interpreting of geologic history and structure from topographic and geologic maps, aerial photographs, geologic sections, structure contour maps and other means of depicting geology. Junior or senior year, first or second semester, one lecture, three laboratory hours per week.

GEOLOGY 445 PHOTOGEOLOGY

3 credit hours. Lectures and Laboratory.

The construction of geologic maps from data on aerial photographs and the geologic interpretation of features shown on aerial

photographs. Graduate, second semester, two lecture and three laboratory hours per week. Elective.

#### PHOTOGRAMMETRIC EQUIPMENT AND LABORATORY FACILITIES

- 2—Complete Multiplex Units with 2 projectors each
  - 2—Abrams Contour Finders
  - 2—Abrams Vertical Sketch Masters Model VE-1
  - 1—Stereocomparagraph
  - 36—Pocket Stereoscopes
  - 1—Saltzman Projector (for enlarging and reducing)
  - 2—Mirror Stereoscopes
  - 1—Parallax Bar
- GEOLOGY DEPARTMENT
- 2—Sketchmasters
  - 7—Mirror Stereoscopes
  - 1—Mahan Plotter
  - 1—K.E.K. Radial Plotter
  - 1—Kail Reflecting Projector
  - 1—Radial Templet Set
  - 1—Large Format Prism Lens Stereoscope (9"×18")
  - 3—Parallax Bars
  - 1—Stereocomparagraph

#### COMPUTING CENTER FACILITIES

Two IBM 1620 computer systems with punched card input-output, 60,000 digit positions of core storage, variable word length, indirect addressing, automatic divide and floating point hardware.

A General Precision LGP-30 computer system with a photoelectric paper tape reader and a tape typewriter as input, with a typewriter and high speed paper tape punch as output.

Auxiliary equipment includes IBM card punch machines, card sorter, paper tape preparation equipment, modern desk calculators, graph plotter and a line printer. A large coding and programming room, offices for the Computer Center personnel, and two classrooms occupy the remainder of the floor.

*Note;* The School of Mines and Metallurgy is only about 5 blocks from the Regional Office of the U.S.G.S. Topographic Branch which has charge of map making for most of the Midwest States. The

Topographic Branch has a very complete line of photogrammetric equipment, and are very cooperative in giving tours and instruction to the university students.

**The Ohio State University, Department of Geodetic Science  
Columbus, Ohio**

**COURSE DESCRIPTIONS (Quarter Hours)**

*Note;* All the courses except the first one are of Graduate level.

**521 PHOTOGRAMMETRY I**

2 hours lecture and 3 hours laboratory each week. 3 credit hours (under-graduate).

History of photogrammetry. Principles of projective geometry, central projection. Photograph and map. Outlines of orientation. Elements of photogrammetric optics. Cameras. Lenses; normal, wide angle, super wide angle, aberrations, distortions and resolving power. Filters, shutters and auxiliary equipment. Principles of photography, development, emulsions, density. Principles of stereovision, natural and artificial stereovision, resolving power, plasticity. Basic parallax formulas. Different methods for stereoscopic viewing. Stereometer instruments. Geometry of single photograph, relief, scale, tilt and determination of outer orientation elements.

**622 PHOTOGRAMMETRY II**

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Stereometer instruments, design, corrections, accuracy, radial triangulation, principal point, nadir point and isocenter triangulations: paper templets, stereotemplets, mechanical templets, analytical solution. Rectification, formulas, instrument design, inversors, practical procedures. Map compilations, sketchmasters, reflecting projectors, photomosaic. Single oblique photogrammetry, trimetrogon charting. Terrestrial photogrammetry. Introduction to second-order stereoscopic methods and instruments.

**623 PHOTOGRAMMETRY III**

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Geometry of projection type instruments. Map coordinates from photo coordinates and photo coordinates from map coordinates. Differentials of Y-Parallax equations. Operations of second-order plotting instruments,

optical mechanical relative orientation, numerical relative orientation, absolute orientation. Differentials of X-Model deformations. Accuracy of relative orientation, accuracy of elevation determination. Design of second-order plotting instruments; multiplex, Kelsh plotter, Wild A8 and similar.

**625 PHOTO-INTERPRETATION**

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Principles of photo-interpretation; various techniques; equipment. Human factor in photo-interpretation. Aerial photography used for photo-interpretation; sharpness of aerial photographs, contrast properties, the effect of sunlight, choice of films and filters, infrared photography, choice of season for aerial photography. Photo-interpretation for planning purposes including highway design. Application of archaeological research. Application for military purposes.

**688 FIELD WORK IN PHOTOGRAMMETRY**

5 credit hours.

Field identification and interpretation for various mapping purposes. Signalization of ground control points and boundary points, aerial photogrammetry and terrestrial photogrammetry. Photography with phototheodolite. Location and determination of photogrammetric baselines in terrestrial photogrammetry. Location and determination of ground control points in aerial and terrestrial photogrammetry. Use of microwave distance measuring equipment.

**721 AERIAL AND TERRESTRIAL PHOTOGRAPHY**

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Optical and photographic properties of photogrammetric cameras. Interior and exterior orientation of photographic pictures. Camera Calibration. Resolution. Practical use of photogrammetric cameras. Various types of photogrammetric cameras, phototheodolite, aerial cameras, stellar cameras,



ballistic cameras, artificial satellite-tracking cameras. Photogrammetric flight mission, survey, airplanes, navigation, etc. Photographic laboratory.

723 STEREPHOTOGRAMMETRY I

3 hours lecture and 3 hours laboratory each week. 4 credit hours.

Theory and practice of first-order stereoplotting instruments. Review of second-order stereoplotting instruments. Kelsh plotter and Multiplex. General theory of first-order and second-order stereoplotting instruments. Zeiss parallelogram. Zeiss Stereoplanigraph, Santoni Stereocartograph, Wild Autograph A7, Wild Autograph A9, Poivilliers Stereotopograph, Nistri and Thompson Plotters. Various methods of relative orientation. Scaling of model. Absolute orientation. Plotting from aerial and terrestrial photography.

725 PHOTOGRAMMETRY IN PRACTICE

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Flight planning. Station project in terrestrial photogrammetry. Determination of geodetic elements in terrestrial and aerial photogrammetry. Accuracy consideration. Signalization of ground control points. Cadastral photogrammetry. Photogeology. Application of photogrammetry in ballistics. Near photogrammetry and microphotogrammetry. Efficiency considerations in photogrammetric operations. Economical considerations, cost estimation and quotation. Organization of photogrammetric projects and establishment of photogrammetric laboratories.

794 SPECIAL STUDIES IN GEODETIC SCIENCE

3 to 9 credit hours.

Assigned reading, laboratory, or field work, under the guidance of a staff member, arranged to meet the requirements of individual students.

795 SEMINAR IN GEODETIC SCIENCE

1 to 3 credit hours.

Seminar in Geodetic Science

823 STEREPHOTOGRAMMETRY II

3 hours lecture and 3 hours laboratory. 4 credit hours.

Theory of errors of exterior orientation, Model errors, Parallax formulas. Model deformations. Theory of critical surfaces. Relative orientation of mountainous models. Theory of errors of interior orientation.

Checking and adjustment of first-order stereoplotting instruments. Grid measurements. Relative orientation, model scaling, and absolute orientation for convergent photography.

824 AERIAL TRIANGULATION

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Aerial triangulation with first-order stereoplotting instrumental method of high-flown models, aeropolygon method, aeroleveling method, method with independent geodetic controls, block triangulation. Derivation of error propagation formulas for strip triangulation. Various strip adjustment procedures. Strip triangulation in flat and mountainous areas. Radial triangulation. Attainable accuracy in aerial triangulation, and economical considerations.

825 ANALYTICAL PHOTOGRAMMETRY

2 hours lecture and 3 hours laboratory each week. 3 credit hours.

Measurement of photographic coordinates with Wild Autograph A7, Nistri stereocomparator and other comparators. Analytical and numerical determination of ground control points from terrestrial photography. Determination of missile trajectory points from photographs taken with ballistic cameras. Determination of orbit points of artificial satellites from photographs taken with satellite-tracking cameras. Analytical and numerical determination of photographic air stations. Analytical aerial triangulation, Stellar-photogrammetry.

950 RESEARCH IN GEODETIC SCIENCE

Research for thesis or dissertation purposes only.

PHOTOGRAMMETRIC EQUIPMENT AND  
LABORATORY FACILITIES

- 1—Wild Aerial Camera RC 5
- 1—Wild Phototheodolite T 30
- 1—Wild Stereometric Camera 40 cm
- 1—Wild Autograph A7 with electric coordinate printer
- 1—Nistri Stereocomparator TA 3
- 1—Kelsh Plotter
- 1—Bausch and Lomb Multiplex
- 1—Bausch and Lomb Rectifier
- 1—Zeiss Multiplex
- 1—Zeiss Rectifier
- 1—Zeiss Stereotope
- 1—Ryker Plotter
- 1—Viewer for Sonne Camera Stereofilm
- 1—Enlarger

- 1—Third-Order Stereoplotter
  - Wild and Delft Mirror Stereoscopes with parallax bars
- 1—Reproduction camera
  - Small Equipment
  - 11 offices and laboratories
  - Complete set of I.T.C. Bibliography cards

## COMPUTING CENTER FACILITIES

- 1—IBM 7094 Computer System
- 1—IBM 1620
- 1—GE 635
- 30 Electric Desk calculators

**Purdue University, School of Civil Engineering  
Lafayette, Indiana**

## COURSE DESCRIPTIONS (Semester Hours)

## CE-205 ENGINEERING SURVEYS II

Sem. 1 and 2. 2 class hours and 3 laboratory hours each week. 3 credit hours.

Second course of basic surveying for undergraduates, which includes a short introduction (3 weeks) in photogrammetry.

## CE-503 PHOTOGRAMMETRY

Sem. 1. 2 class hours and 3 laboratory hours per week. 3 credit hours.

Theory and construction of photographic materials and cameras; terrestrial photogrammetry; geometry of photograph; rectification, mosaics, radial line triangulation; theory of parallax; theory and construction of parallax measuring instruments and optical and mechanical projection systems; interior, relative and absolute orientations; map compilation and engineering applications.

## CE-603 ADVANCED PHOTOGRAMMETRY

Sem. 2. 2 class hours and 3 laboratory hours per week. 3 credit hours.

Theory of orientations for vertical and convergent photography; theory of errors and error propagation in photogrammetry; calibration of photogrammetric instruments; various aero-triangulations—their application and error propagation; determination of maximum bridging distances and economical considerations.

## CE-604 ANALYTICAL PHOTOGRAMMETRY

Summer Session. 2 class hours and 3 laboratory hours per week. 3 credit hours.

Theory and design of analytical photogrammetric instruments; analytical orientations; space resections and intersections; analytical aero-triangulation; automation in computations; stellar photogrammetry.

## CE-567 ENGINEERING USES OF AERIAL PHOTOGRAPHY

Sem. 1. 2 class hours and 3 laboratory hours per week. 3 credit hours.

Air photo interpretation and application to engineering surveys for city planning, highways, airports, and transportation in general, with emphasis on interpretation of land forms and their influence on location studies.

## CE-667 AIRPHOTO INTERPRETATION OF SOILS AND ROCKS

Sem. 2. 1 class hour, 6 laboratory hours each week. 3 credit hours.

Principles and techniques of airphoto interpretation applicable to the identification and evaluation of soils and rocks; use of aerial photography in the location of materials of construction. Three field trips are required with transportation cost involved on two, and transportation and three-day subsistence involved on the third.

## PHOTOGRAMMETRIC EQUIPMENT AND LABORATORY FACILITIES

- 1—Kelsh Plotter
  - Several Multiplex Units
- 5—Abrams Contour Finders
- 2—Fairchild Stereocomparagraphs
- 2—Fairchild Parallax Bars
- 12—Abrams Vertical Sketchmasters
- 2—Old Delft Scanning Stereoscopes
- 1—Fairchild Mirror Stereoscope
- 1—Aristo Coordinatograph
  - Airphoto library and photographic dark room
- 1—Lazy Daisy Mechanical Triangulator
- 2—Oblique Sketchmasters

## COMPUTING CENTER FACILITIES

- 1—IBM 7094 Computer System
- 1—LGP-30 Electronic Computer
- 21—Electric Desk Calculators

**Syracuse University, Department of Civil Engineering  
Syracuse, New York**

**COURSE DESCRIPTIONS—(Semester Hours)**

**CE-101G PHOTOGRAMMETRY**

3 Credit Hours. One term.

A beginning course in photogrammetry which includes introduction to photogrammetry, aerial cameras, geometry of the single vertical photograph, stereoscopy and parallax, geometry of overlapping vertical photographs, planning aerial photography, ground control, radial line plotting, mosaics, geometry of the tilted photograph, scale point method of tilt determination, introduction to stereoscopic plotting instruments including Contour Finder, Stereocomparagraph, Multiplex, Balplex, and Kelsh Plotter, photo interpretation. Laboratory exercises include the use of the Contour Finder, Stereocomparagraph, Reed Auto Focus Projector, and Saltzman Projector.

**CE-210 ANALYTICAL PHOTOGRAMMETRY I**

3 Credit hours. One term.

An introduction to analytical photogrammetry including Church resection and orientation, trimetrogon, and 4 pt. control extension; triangulation methods of G. H. Schut, and U.S.C. & G. S.

**CE-211 ANALYTICAL PHOTOGRAMMETRY II**

3 Credit Hours. One term.

Continuation of CE-210; An introduction to the algorithms of Schmid and Brown, analytics of panoramic and strip photography, stellar camera calibration.

**CE-212 INSTRUMENTAL PHOTOGRAMMETRY I**

3 Credit Hours. One term.

This course is concerned with the study of the mathematical theory of the stereo model as appropriate to the plotting instrument, and with the various methods of instrumental triangulation along with auxiliary devices such as the statoscope and A.P.R. During the laboratory the student is able to use the Multiplex, Kelsh, Balplex Stereotope and Ryker plotters.

**CE-213 INSTRUMENTAL PHOTOGRAMMETRY II**

3 Credit Hours. One term.

This course includes the theory and design of the major photogrammetric plotting instruments, camera calibration, and photogrammetry applied to highways, cadastre.

**CE-214 TERRESTRIAL AND NON-TOPOGRAPHIC PHOTOGRAMMETRY**

3 Credit Hours. One term.

The course is concerned with applications of photogrammetry to other than the aerial case. The subjects include the photo-theodolite, the short focus precision camera and its calibration, object space coordinate errors as a function of errors in interior and exterior orientation. Laboratory exercises include use of the Wild Photo-theodolite, Wild C-12 fixed base stereocamera, the Zeiss stereocomparator and the Mann Comparator.

**CE-301 and CE-302 SPECIAL INVESTIGATIONS**

3 Credit Hours. One term.

For students with a special interest in pursuing some phase of photogrammetry or geodesy to a greater depth than possible in normal courses. In the past students have done work in photogrammetry in highway work, camera calibration, analytical triangulation.

**CE-397 THESIS IN PHOTOGRAMMETRY**

6 Credit Hours.

The following photogrammetry courses are available through the College of Forestry, of the State University of New York at Syracuse University.

**FOREST MANAGEMENT 120 PHOTOGRAMMETRY (MENSURATIONAL)**

3 Credit Hours. One term.

Stereoscopic examination of aerial photographs. Methods of measuring tree heights; estimation of forest areas, types, condition classes, and timber volume from aerial photographs. Ground work pertaining to cull, volume tables, composition of species and related factors. Flying specifications. Recent developments.

**FOREST MANAGEMENT 121 (LAND MANAGEMENT)**

3 Credit Hours. One term.

Photogrammetric engineering methods in forest land management, cadastral mapping, property control, tax problems, protection, timber and range management, multiple use planning. Location and preliminary planning of transportation systems and other engineering functions.

PHOTOGRAMMETRIC EQUIPMENT AND  
LABORATORY FACILITIES

- 1—Mann Comparator Type 422C
- 1—Kelsh Plotter
- 1—Balplex Plotter
- 1—Multiplex Plotter—3 projector
- 1—Zeiss Stereotope
- 1—Ryker PL-4 Plotter
- 1—Saltzman Projector
- 1—Reed Autofocus Projector
- 1—Zeiss Stereocomparator for Terrestrial Photography
- 1—Zeiss Photo-Theodolite and Subtense Bar
- 1—Wild Photo-Theodolite and Subtense Bar
- 1—Wild C-12 Stereometric Camera (120 cm. base)
- 1—Zeiss Hand Held Aerial Camera
- 1—K-24 Aerial Camera
- 2—Modified K-21 Cameras for Close Range Photography

- 1—Wild Pug II Point Marking Instrument
- Also numerous small equipment such as contour finders, stereo-comparagraphs, sketchmasters, etc.
- Two plotting rooms are available and a photographic laboratory.
- A mensuration laboratory with controlled environment enables analytical studies of high precision to be conducted.

## COMPUTING CENTER FACILITIES

- 1—IBM 7070-1401 Computing System
- 1—Royal McBee LGP 30
- 1—Burroughs E-101

The computing system includes the necessary supporting equipment such as key punch units, sorter, collator, IBM 407, reproducer, verifier, xy plotter, etc.

**The University of Texas, Department of Civil Engineering  
Austin, Texas**

COURSE DESCRIPTIONS (Semester Hours)  
CE-268, 368 ANALYTICAL PHOTOGRAMMETRY  
2 or 3 credit hours.

Geometry of photographs, tilt analysis, orientation study, stereoscopic model deformation, and photogrammetric instrumentation.

CE-368K PHOTOGRAMMETRY AND MAPPING  
3 credit hours.

Geometry of aerial photographs, planimetric and topographic measurements, map compilation, and mapping processes using photographs.

CE-392K.1. PHOTOGRAMMETRY APPLIED TO  
ENGINEERING AND SCIENCE RESEARCH  
3 credit hours.

Photography, measurements from photographs and evaluation and interpretation of photographic measurements applied to research projects. Projects may be selected by the student.

CE-392K.2. AERIAL PHOTOGRAPHIC INTER-  
PRETATION AND EVALUATION  
3 credit hours.

Principles and methods of photographic interpretation. Problems include vegetation, hydrology, soils, geology; planning for industry, cities, and transportation systems.

CE-397.4 SPECIAL STUDIES IN CIVIL ENGINEERING

Sec. 4, 2 to 6 credit hours.

Surveying and photogrammetry

GEO. 377K MAPS AND AIR PHOTOS\*  
3 credit hours

GEO. 391.3 SEMINAR IN GEOLOGY, STRUCTURAL GEOLOGY AND GEOMORPHOLOGY\*  
3 credit hours

GEO. 394.3 RESEARCH IN GEOLOGY, STRUCTURAL GEOLOGY AND GEOMORPHOLOGY\*  
3 credit hours.

AST. 392 PROCEDURES ON OBSERVATIONAL ASTRONOMY\*  
3 credit hours.

PHOTOGRAMMETRIC EQUIPMENT AND  
LABORATORY FACILITIES

- 1—Two-Projector Multiplex
- 2—Two-Projector Balplex (One instrument in Civil Engineering and one in Geology)
- 1—Coordinate measuring instrument Stereoscopes

## COMPUTING CENTER FACILITIES

- 1—Control Data Corporation 1604
- 1—IBM 1620
- 1—LGP 30

\* Geology and Astronomy Courses may involve considerable photogrammetry and/or photo interpretation *but* varies from year to year.

The University of Wisconsin, Department of Civil Engineering  
Madison, Wisconsin

## COURSE DESCRIPTIONS—(Semester Hours)

## CE-400 PHOTOGRAMMETRY

3 credit hours.

The geometry of the aerial photograph; factors in flight planning; ground control for aerial mapping; principles of radial line plotting; stereoscopy and parallax; geometry of overlapping vertical photographs, elements of photo-interpretation; mosaics.

## CE-402 ADVANCED PHOTOGRAMMETRY

3 credit hours.

Cameras and photography, terrestrial photograph, stereoscopic plotting instruments, map compilation; oblique photographs; mapping from oblique photographs; rectification; convergent photography; analytical photogrammetry; photogrammetry applied to research.

## CE-404 ENGINEERING APPLICATIONS OF AIR-PHOTO INTERPRETATION II

3 credit hours.

Determination of soil, bedrock and drainage characteristics of land areas by airphoto interpretation; engineering characteristics of landforms; use of airphoto interpretation for engineering soil surveys, construction materials surveys, and site and route location.

## CE-699 ADVANCED INDEPENDENT INVESTIGATIONS

Credit hours variable.

Research problems with opportunity for independent work.

## GEOGRAPHY 630 ELEMENTARY AIR PHOTO INTERPRETATION

3 credit hours.

Use of air photos as tools for topical research in the social and physical sciences  
Field work.

## PHOTOGRAMMETRIC EQUIPMENT AND LABORATORY FACILITIES

- 1—Nistri Stereoplotter
- 1—Wild Photo-theodolite
- 20—Stereocomparators, Fairchild
- 2—Metal, Slotted templet, radial line plotting sets
- 4—Vertical Sketchmasters
- 1—Saltzman opaque projector
- 2—Comparators
- Normal Lens, mirror and prism stereoscopes

Laboratory facilities include a photo library, laboratory for photo interpretation courses, photographic dark room with standard dark room equipment, laboratory for mosaic and large layout work, map library, shop facilities for instrument repair and construction of special equipment.

## COMPUTING CENTER FACILITIES

- Control Data Corporation 3600
- Control Data Corporation 1604
- Control Data Corporation 160
- International Business Machine 1460
- International Business Machine 1620 Model I (Engr. Comp. Center)
- International Business Machine 1620 Model II (Engr. Comp. Center)

