Mt. San Jacinto College
Integrated Course Outline of Record

Form B

Submitted by:	James Bae	**Date:**	11/12/2020

Department	Subject	Course Number	Title
Engineering: Technologies	Engineering: Technologies ENGR	567	Global Positioning Systems for Surveying (formerly ENGR-167 Global Positioning Systems)

Units/Hours

Each lecture unit requires 1 hour per week of class time, and 2 hours per week of study outside of class.
Each laboratory unit requires 3 hours per week of class time.
Each activity unit requires 2 hours per week of study outside of class.

Lecture Units	Lab Units	Total Units
2.50	0.50	3.00
Lecture Contact Hours	**Lab Contact Hours**	**Total Contact Hours**
40.00 - 45.00	24.00 - 27.00	64.00 - 72.00
Lecture Homework Hours	**Lab Homework Hours**	
80.00 - 90.00	0	

Stand Alone:

Program Applicable

AA/AS Degree General Ed Breadth Area(s):

-none-

General Education Justification:

Maximum Enrollment:	40
Maximum Enrollment Justification:	Justification:
Grading Method:	Letter Grade or P/NP
TOP code:	0957.30*

Can be Taken 1 **time(s) for credit** (max 4)

- [ ] - Visual or Performing Arts course that is required to meet major requirements for UC/CSU
- [ ] - Intercollegiate athletics course
- [ ] - Academic/vocational competition course

Catalog Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course). (**75 words** or less in gray box below).

This course provides students with fundamental knowledge for applying GPS technology in the field for engineering based operations. Emphasis is placed on satellite systems- measurements for positional accuracy- statistical adjustments- post-processing- real-time and post-differential correction- field data collection- and mapping models. The course provides hands-on experience with GPS instruments used for field-based survey and planimetric mapping.

Schedule Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course). (**25 words** or less in gray box below).

This course provides students with GPS fundamentals for positional accuracy- real-time and post-differential correction- field data collection- and mapping models applied by surveyors.

Need for the course:

This course continues the collegeâ€™s curriculum for developing marketable skills in vocational areas of Engineering, Surveying, Geographic Information Systems, and Environmental Sciences. This course supports and is attached to: ENGR - Engineering: Drafting Technology - Certificate (Elective), ENGR - Engineering: Surveying ECC (Required)

Prerequisite(s):

Prerequisites go through a separate approval process. See Forms E1-E6 for details.
(For further clarification, contact the Prerequisite Subcommittee)

-none-

Corequisite(s):

Corequisites go through a separate approval process. See Forms E1-E6 for details.

-none-

Recommend Preparation:

Recommended Preparation goes through a separate approval process. See Forms E1-E6 for details.

- MATH 094 or
- MATH 096 or
- MATH 105

Other Enrollment Criteria:

-none-

Learning Objectives:

(please number each objective and express in behavioral terms)
Upon the completion of the course the student will be able to do the following:

1. Operate a precision GPS unit and understand multi-functionality of data acquisition.
2. Design and organize GPS data collection procedures.
3. Collect, input, edit and process data acquired with GPS in the field.
4. Evaluate satellite system transmission, receiver signals and positioning accuracy.
5. Manipulate post-processed data.
6. Calculate statistical measures of error for least square adjustments.
7. Export data to mapping software programs, for instance, computer aided drawings or Geographic Information Systems.
8. Apply appropriate geodetic reference systems and mapping models.

Course Content:

(please number the outline of main topics and subtopics)

1. Global Positioning Systems Fundamentals
    1. What is GPS?
    2. Historical perspective
    3. Major uses of GPS
    4. Surveying transition to GPS
2. Geodetic Reference Systems
    1. Geodetic Aspects
    2. Tectonic Plate Motion
    3. Time Systems
    4. Datum
    5. Ellipsoid
3. Satellite Systems
    1. Early Satellite Systems
    2. Satellite Orbits and Visibility
    3. Topocentric Motion
    4. Satellite Transmissions and Receiving Stations
    5. GLONASS
4. Least Square Adjustments
    1. Statistical Survey Measurements
    2. Stochastic and Mathematical Models
    3. Variance-Covariance Propagation
    4. Mixed Adjustment Model
    5. Equation Models and Sequential Solution
    6. Weighted Parameters, Conditions and Constraints
    7. Reliability and Blunder Detection
5. Observables
    1. Pseudoranges and Carrier Phases
    2. Differencing
6. Troposphere and Ionosphere
    1. Tropospheric Refraction and Delay
    2. Ionospheric Refraction
7. Processing
    1. Antenna Corrections
    2. Satellite Antenna Phase Center Offset
    3. Receiver Antenna Phase Center Offset and Variation
    4. Multipath
    5. Geometry-free Solutions
    6. Real-time Precise Point Positioning
    7. Ambiguity Function
8. Accuracy Characteristics
    1. Vertical accuracy

2. Horizontal accuracy
3. Position Dilution of Precision (PDOP)
4. Network Adjustments

9. Field Data Collection
    1. Navigation Fundamentals
    2. Base Stations
    3. Rover Status
    4. Feature Collection and Input
    5. Post-Field Processing
    6. Data transfer
10. Database Design
    1. Metadata
    2. Data Dictionaries
    3. Data download and integration
    4. Editing Data
11. Advanced Data Analysis Techniques
    1. Filtering
    2. Error Detection
    3. Data Clean up
12. Two-dimensional Geodetic Models
    1. Ellipsoidal Model
    2. Conformal Mapping Model
13. Data Export
    1. Geographic Information Systems
    2. Computer Aided Drafting
    3. Other Mapping Software

Lab Content:

(please number the outline of main topics and subtopics)

1. Safety
    1. Environmental awareness
    2. Equipment safety
    3. Safe equipment use and storage
    4. Equipment inventory/checklist
2. Data Collection
    1. Planning and Preparation
    2. Role assignments
    3. Data collection methods and tables
    4. Data interfaces and download
3. Application of Statistical Survey Measurements
    1. Stochastic and Mathematical Models
    2. Variance-Covariance Propagation
    3. Mixed Adjustment Model
    4. Equation Models and Sequential Solution
    5. Weighted Parameters, Conditions and Constraints
    6. Reliability and Blunder Detection
4. Observables
    1. Pseudoranges and Carrier Phases
    2. Differencing
5. Processing
    1. Antenna Corrections
    2. Satellite Antenna Phase Center Offset
    3. Receiver Antenna Phase Center Offset and Variation

4. Multipath
5. Geometry-free Solutions
6. Real-time Precise Point Positioning
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6. Accuracy Characteristics
    1. Position Dilution of Precision (PDOP)
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8. Database Design
    1. Metadata
    2. Data Dictionaries
    3. Data download and integration
    4. Editing Data
9. Advanced Data Analysis Techniques
    1. Filtering
    2. Error Detection
    3. Data Clean up
10. Data Export
    1. Geographic Information Systems
    2. Computer Aided Drafting
    3. Other Mapping Software

Methods of Instruction:

Methods of instruction may include, but are not limited to the following:

- **Method:** Observation and Demonstration
  Integration: Demonstrations by the instructor on the proper use and calculation of GPS data on professional GPS units and mapping programs.
- **Method:** Homework
  Integration: Reading and calculation assignments to learn GPS capabilities, data outputs, calculation and integration into mapping.
- **Method:** Group Projects
  Integration: Group projects to practice collection of GPS data, calculate and incorporate information into survey maps.
- **Method:** Field Experience
  Integration: An instructor led final project presents students with an opportunity to interact one-on-one with the instructor or as a collaborative team. Feedback and evaluation can be facilitated by the instructor while assessing student ability to integrate the content of this course in a GPS application that is a real-world engineering scenario.
- **Method:** Online Activity/Discussion
  Integration: Whenever appropriate, internet exercises, power point presentations, videos and software tutorials and simulations will be used to explain GPS systems function, demonstrate various available GPS units and how they are used in the field, and to demonstrate use of GPS data in mapping.
- **Method:** Lab Activities
  Integration: Field exercises provide students with hands-on experience using precision techniques for surveying with GPS. Field exercises provide students an opportunity to demonstrate knowledge and skills.
- **Method:** Lecture
  Integration: Lecture and discussion will explain the fundamentals of satellite positioning systems, the history

and future of GPS, and data use standards and practices.

- **Method:** Readings
  Integration: Technical and historical supplemental reading assignments will explain to students how GPS works, its applications and commercially available professional units.
- **Method:** Visiting Lecturers
  Integration: Professionals will provide information on the available GPS technology and how they use it in their careers.

Methods of Evaluation:

A student's grade shall be determined by the instructor using multiple measures of performance related to the course objectives. Methods of evaluation may include but are not limited to the following:

- **Method:** Quizzes
  Integration: Quizzes and exams will objectively assess student comprehension of GPS techniques and applications, for a variety of scenarios. Use of a variety of question formats to assess student comprehension of GPS techniques and applications, and to assess student ability to think critically about the appropriateness of techniques for particular survey applications. Topics will include how to collect, evaluate and incorporate GPS data into surveying methods and reports, including equipment operation and limitations. Quizzes can be used for in-class practice and immediate feedback and evaluation by instructor.
- **Method:** Class Participation
  Integration: In-class participation offers students an opportunity to demonstrate understanding of the course content while working as a team or with the instructor, and will be assessed as participation points
- **Method:** Group Projects
  Integration: A group project provides students an opportunity to demonstrate excellence in organization and cooperation. The project will be peer evaluated for individual student participation and instructor evaluated for conceptual, methodological and technical validity or accuracy. Groups will work together to demonstrate the appropriate operation of equipment, collection of GPS data, calculation and manipulation of data sets, and use in example surveying reports and mapping.
- **Method:** Homework
  Integration: Weekly homework assignments will test student application of the technology and theory to various problem solving situations. Assignment topics will include operation of equipment and equipment features; collection of GPS data and team coordination scenarios; calculation and manipulation of data sets; and use in example surveying reports and mapping.
- **Method:** Class Performance
  Integration: Field exercises will test student understanding of in-field functionality of GPS equipment and application of concepts in real world situations.
- **Method:** Simulation
  Integration: Supplementary activities, such as software tutorials and simulations, may be assigned as additional opportunities for students to demonstrate understanding and skill in GPS capabilities, calculation, and use.
- **Method:** Projects
  Integration: A final instructor-led project will allow students to demonstrate their ability to operate equipment, collect and calculate accurate data, and use professional standards and practices to incorporate the data into survey maps.

Examples of Assignments:

Students will be expected to understand and critique college level texts or the equivalent. Reading and writing, as well as out of class assignments are required. These assignments may include but are not limited to the following:

1. Select a location for GPS data collection of at least 10 points. Using a precision GPS unit and standard handheld model collect data for each point. While collecting data for each point document satellite signal transmission and reception data. Post-process the data collected for the 10 points from each unit separately and then compare the positional accuracy between the units. Describe the differences in levels of precision

using statistical measures of error for least square adjustments. Create a two-dimensional map that illustrates the differences in positional accuracy between GPS units. Turn in a written summary comparing the accuracy and technical functionality of the two units. Turn in a map illustrating the positional differences for the 10 points.

2. Critique the vendor demonstration of GPS related hardware and software. Use the Internet or other resource to locate similar technology currently available on the market by another vendor. Itemize the pros and cons between the technology demonstrated by the vendor and that available elsewhere. Write a one page double space assessment of your findings. Turn in your itemization of the pros and cons and your one page assessment of vendor specific products.
3. Convert and input the data collected during the field trip into a database management software program. Add field attributes to the database for describing the data features. Maintain metadata on the database file you created and create a data dictionary that describes database attributes, including attribute codes that you design. Import the database into a computer mapping software program, either CAD or GIS, to generate a map. Turn in metadata, data dictionary and computer generated map for credit.
4. Calculate the root mean square error for the attached list of locations.

Textbooks:

- Van Sickle, V. (2015). *GPS for Land Surveyors 4th Ed* CRC Press. ISBN: 9781466583108

Other Resources:

Minimum Qualification

- Engineering (Masters Required) **or**
- Engineering Support **or**
- Engineering Technology (Masters Required)