# ENGT M10: INTRODUCTION TO UNMANNED AERIAL VEHICLE TECHNOLOGY

**Originator**

srelle

**Co-Contributor(s)**

| Name(s) |
| --- |
| Rad, Khosrow (krad) |

**College**

Moorpark College

**Attach Support Documentation (as needed)**

Engr Adv Comm Meet_Agenda_2019.pdf
Recommendations of the committee.pdf
Attendees for Spring 2019 Advisory Committee.pdf
ENGT M10_state approval letter_CCC000612480.pdf

**Discipline (CB01A)**

ENGT - Engineering Technology

**Course Number (CB01B)**

M10

**Course Title (CB02)**

Introduction to Unmanned Aerial Vehicle Technology

**Banner/Short Title**

Intro to UAV Tech

**Credit Type**

Credit

**Start Term**

Fall 2020

**Catalog Course Description**

Introduces topics related to Unmanned Aerial Vehicle (UAV) systems, regulations, and operating principles including aerodynamics, propulsion, flight mechanics, materials, design, mission planning, and various operating environments. Includes historical background, career opportunities, and professionalism in operating UAVs. Presents a wide range of UAV technology and its various uses in industry. Studies current and former Federal Aviation Administration (FAA) regulations regarding UAV systems and operations. Develops basic operating skills for quad-rotor configured unmanned aircrafts.

**Additional Catalog Notes**

This course prepares students for Part 107 Drone (UAS - Unmanned Aerial Systems) licensing.

**Taxonomy of Programs (TOP) Code (CB03)**

0924.00 - *Engineering Technology, General (requires Trigonometry)

**Course Credit Status (CB04)**

D (Credit - Degree Applicable)

**Course Transfer Status (CB05) (select one only)**

B (Transferable to CSU only)

**Course Basic Skills Status (CB08)**

N - The Course is Not a Basic Skills Course

**SAM Priority Code (CB09)**

C - Clearly Occupational

**Course Cooperative Work Experience Education Status (CB10)**
N - Is Not Part of a Cooperative Work Experience Education Program

**Course Classification Status (CB11)**
Y - Credit Course

**Educational Assistance Class Instruction (Approved Special Class) (CB13)**
N - The Course is Not an Approved Special Class

**Course Prior to Transfer Level (CB21)**
Y - Not Applicable

**Course Noncredit Category (CB22)**
Y - Credit Course

**Funding Agency Category (CB23)**
A - Primarily Developed Using Economic Development Funds

**Course Program Status (CB24)**
1 - Program Applicable

**General Education Status (CB25)**
Y - Not Applicable

**Support Course Status (CB26)**
N - Course is not a support course

**Field trips**
May be required

**Faculty notes on field trips; include possible destinations or other pertinent information**
Naval Base in Point Mugu or in Port Hueneme; engineering firms in the area
(alternative assignments maybe substituted for the field trip).

**Grading method**
Letter Graded

**Alternate grading methods**
Credit by exam, license etc.
Student Option- Letter/Pass

**Does this course require an instructional materials fee?**
No

**Repeatable for Credit**
No

**Is this course part of a family?**
No

## Units and Hours

**Carnegie Unit Override**
No

## In-Class

**Lecture**
**Minimum Contact/In-Class Lecture Hours**
35
**Maximum Contact/In-Class Lecture Hours**
35

**Activity**

**Laboratory**
**Minimum Contact/In-Class Laboratory Hours**
52.5
**Maximum Contact/In-Class Laboratory Hours**
52.5

## Total in-Class

**Total in-Class**
**Total Minimum Contact/In-Class Hours**
87.5
**Total Maximum Contact/In-Class Hours**
87.5

## Outside-of-Class

**Internship/Cooperative Work Experience**

**Paid**

**Unpaid**

## Total Outside-of-Class

**Total Outside-of-Class**
**Minimum Outside-of-Class Hours**
70
**Maximum Outside-of-Class Hours**
70

## Total Student Learning

**Total Student Learning**
**Total Minimum Student Learning Hours**
157.5
**Total Maximum Student Learning Hours**
157.5

**Minimum Units (CB07)**
3
**Maximum Units (CB06)**
3

**Prerequisites**
MATH M06 - Trigonometry or MATH M07 - Precalculus and Trigonometry

## Entrance Skills

**Prerequisite Course Objectives**
MATH M06-identify special triangles and their related angle and side measures.
MATH M06-evaluate the trigonometric function of an angle in degree and radian measure.
MATH M06-solve trigonometric equations, triangles, and applications.
MATH M06-graph the basic trigonometric functions and apply changes in period, phase and amplitude to generate new graphs.
MATH M06-convert between polar and rectangular coordinates and equations.
MATH M06-represent a vector (a quantity with magnitude and direction) in the form and ai+bj.
MATH M07-graph functions and relations in rectangular coordinates and polar coordinates.
MATH M07-analyze and identify the features of the graphs and/or the equations of functions and relations.
MATH M07-solve systems of equations and inequalities.
MATH M07-apply functions to model real world applications.

MATH M07-identify special triangles and their related angle and side measures.
MATH M07-evaluate the trigonometric function at an angle whose measure is given in degrees and radians.
MATH M07-solve trigonometric equations, triangles, and their related applications.
MATH M07-convert between polar and rectangular coordinates.
MATH M07-represent a vector (a quantity with magnitude and direction) in the form and ai+bj, compute the magnitude of a vector, and graph vectors on the xy-plane.
MATH M07-perform vector operations including addition, subtraction, scalar multiplication, and dot product. Determine the angle between two vectors and when vectors are parallel or perpendicular, and compute the projection vector.
MATH M07-write the standard form of a circle given the general equation.

## Requisite Justification

**Requisite Type**
Prerequisite

**Requisite**
MATH M06 - Trigonometry

**Requisite Description**
Course not in a sequence

**Level of Scrutiny/Justification**
Content review

**Requisite Type**
Prerequisite

**Requisite**
MATH M07 - Precalculus and Trigonometry

**Requisite Description**
Course not in a sequence

**Level of Scrutiny/Justification**
Content review

**Student Learning Outcomes (CSLOs)**

| | Upon satisfactory completion of the course, students will be able to: |
|---|---|
| 1 | explain the challenges, benefits and uses of Unmanned Aerial Vehicle (UAV) technology in military and commercial business sectors. |
| 2 | demonstrate knowledge of Federal Aviation Administration (FAA) regulatory standards applied to real life UAV operation. |
| 3 | operate a quad-rotor aircraft and perform simple maneuvers through and around obstacles. |
| 4 | trouble shoot a malfunctioning UAV. |

**Course Objectives**

| | Upon satisfactory completion of the course, students will be able to: |
|---|---|
| 1 | apply the relationships between lift, drag, velocity, and weight of an aircraft or rotorcraft in steady-level flight. |
| 2 | analyze the various components of the mission of an Unmanned Aircraft System (UAS), including the planning of the mission, the launch and the recovery of the unmanned aircraft. |
| 3 | apply general thrust and efficiency equations for propellers and jet engines to evaluate the performance of an air vehicle. |
| 4 | identify and explain the principles governing the functions of accelerometers, gyroscopes, magnetometers, Global Positioning Systems (GPS), and other Micro-Electro-Mechanical Systems (MEMS) as sensors. |
| 5 | collect data through implementation of accelerometers, gyroscopes, magnetometers, GPS, and MEMS as imaging, heat, and humidity sensors. |

| | |
|---|---|
| 6 | demonstrate knowledge of materials used in manufacturing of UAVs, and describe the pros and cons of each material. |

## Course Content

**Lecture/Course Content**

1. **(10%) - Overview of Unmanned Aerial Vehicle (UAV) systems**
   a. History of development
   b. Classification of unmanned vehicles
2. **(15%) - Fundamental topics in flight mechanics for UAV systems**
   a. Aerodynamics
   b. Performance
   c. Propulsion
   d. Structures
3. **(10%) - Overview of mission planning**
   a. Concept of Operations (CONOPS)
   b. Ground control stations
   c. Atmospheric and environmental monitoring
4. **(20%) - Overview of sensor-based payloads**
   a. Imaging
   b. Meteorological sensors
   c. Pseudo-satellites
   d. Weapons payloads (brief discussion)
5. **(15%) - Data-link functions and attributes**
   a. Interference
   b. Antennas
   c. Data transfer
6. **(15%) - Overview of launch and recovery methods**
   a. Vehicle Take Off and Landing (VTOL)
   b. Parachutes
   c. Trade-offs
7. **(15%) - Current and previous Federal Aviation Administration (FAA) regulations for UAVs**
   a. Emphasis on Part 107 licensing for commercial UAVs

**Laboratory or Activity Content**

1. **(45%) - Hands-on practice operating a UAV system**
   a. Piloting around obstacles
   b. Understanding orientation
   c. Interfacing with sensors and pilot software
   d. troubleshooting
2. **(45%) - Data collection and processing with on-board UAV sensors**
   a. Magnetometers
   b. Accelerometers
   c. Global Positioning Systems (GPS)
   d. Imaging, temperature, humidity sensors
   e. troubleshooting
3. **(10%) - Basic concepts of video capture and data transfer**

## Methods of Evaluation

**Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):**

Problem solving exercises
Skills demonstrations
Written expression

**Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):**

Computational homework
Group projects
Individual projects

Laboratory activities
Laboratory reports
Objective exams
Problem-solving exams
Quizzes
Skills demonstrations
Skill tests

## Instructional Methodology

**Specify the methods of instruction that may be employed in this course**

Computer-aided presentations
Collaborative group work
Class activities
Class discussions
Demonstrations
Field trips
Group discussions
Guest speakers
Instructor-guided interpretation and analysis
Instructor-guided use of technology
Laboratory activities
Lecture
Practica
Small group activities

**Describe specific examples of the methods the instructor will use:**

The instructor will use PowerPoint presentations, problem solving exercises, experimentation, and demonstrations to explain the concepts of the course.

## Representative Course Assignments

**Writing Assignments**

1. Short essays based on topics in UAV technology. Prompts such as: Name and describe two agricultural uses of UAVs, and evaluate the benefits and challenges of these operations.
2. Write a technical report documenting the design and feasibility of a new development in the use of UAV technology.

**Critical Thinking Assignments**

1. Use UAV and aerodynamic concepts learned in class to solve problems with multiple constraints. For example, a customer has asked if your company's UAV is capable of delivering a 5-kg package to a destination that is 1-km away in 30 minutes. Given this information, calculate the range and endurance of your aircraft and determine if it can complete the mission? Also, what could be changed to improve the performance of your UAV?
2. Apply knowledge from the lecture and the textbook to synthesize and analyze data gathered from experiments. For example, using an accelerometer take measurements of the Earth’s gravitational acceleration at various spots around the campus. Find the mean and the standard deviation of the measurements, and determine the accuracy of the sensor. Indicate whether or not more measurements would improve the accuracy, and explain your reasoning.

**Reading Assignments**

1. Read assigned chapters from the UAV textbook to be able to answer questions from the lecture, and to prepare for the accompanying laboratory experiments. Examples would be: Identify and describe the need for magnetometers in UAV applications. Describe how an airfoil generates lift. Propeller blades are airfoils that twist, explain why that is.
2. Read scientific and technical journal articles relevant to advances in UAV technology in order to expand understanding of their usage in research and industry.

**Skills Demonstrations**

1. Illustrate the ability to construct, fly, and test the operation of a UAV in a laboratory environment using the materials provided with a given set of constraints.
2. Illustrate the ability to troubleshoot a malfunctioning UAV system equipped with sensors using the appropriate theoretical concepts and testing tools learned in class.

## Outside Assignments

**Representative Outside Assignments**

1. Conduct library or online research related to topics in UAV technology. Topics may include innovative uses of UAV technology, new UAV designs, novel configurations of vehicle take-off and landing, uses of unique materials in UAV construction, etc.

2. Complete weekly homework assignments that consist of solving problems related to flight mechanics, propulsion, FAA regulations and other topics covered in the course. Weekly homework problems will consist of at least 8 problems with 2 problems of increased difficulty that may require additional research. Examples could include: Calculate the lift force required for the takeoff of an 11-lb fixed wing aircraft which is equipped with a National Advisory Committee for Aeronautics (NACA) 2412 airfoil. According to 14 CFR (Code of Federal Regulations) Part 107, a special use airspace unmanned aircraft system should be weighing less than how many lbs?

## Articulation

**Equivalent Courses at other CCCs**

| College | Course ID | Course Title | Units |
|---|---|---|---|
| Orange Coast College | A131 and A151 | Intro. to Unmanned Aircraft Systems Lecture and Lab | 3 and 1 |
| College of San Mateo | ENGR 680MB | Intro. to Rocket and Drone Science and Technology | 3 |
| Mission College | CIS 035 | Intro. to Drones and Unmanned Aerial Vehicles | 4 |
| Southwestern College | GEOG 108 | Intro. to Unmanned Aerial Systems (Drones) | 4 |

## District General Education

## A. Natural Sciences

## B. Social and Behavioral Sciences

## C. Humanities

## D. Language and Rationality

## E. Health and Physical Education/Kinesiology

## F. Ethnic Studies/Gender Studies

**Course is CSU transferable**

Yes

**CSU Baccalaureate List effective term:**

Fall 2020

## CSU GE-Breadth

## Area A: English Language Communication and Critical Thinking

## Area B: Scientific Inquiry and Quantitative Reasoning

## Area C: Arts and Humanities

## Area D: Social Sciences

## Area E: Lifelong Learning and Self-Development

## CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

## IGETC

## Area 1: English Communication

## Area 2A: Mathematical Concepts & Quantitative Reasoning

## Area 3: Arts and Humanities

## Area 4: Social and Behavioral Sciences

## Area 5: Physical and Biological Sciences

## Area 6: Languages Other than English (LOTE)

## Textbooks and Lab Manuals

**Resource Type**
Textbook

**Classic Textbook**
No

**Description**
Fahlstrom, Paul, and Thomas Gleason. *Introduction to UAV Systems*. 4th ed. Wiley, 2012.

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**Resource Type**
Textbook

**Classic Textbook**
No

**Description**
Marshall, Douglas, et al. eds. *Introduction to Unmanned Aircraft Systems.* 2nd ed. CRC Press, 2016.

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**Resource Type**
Textbook

**Classic Textbook**
No

**Description**
Beard, Randal, and Timothy McLain. *Small Unmanned Aircraft: Theory and Practice*. Princeton UP, 2012.

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## Library Resources

**Assignments requiring library resources**

Reading, writing, critical thinking, and outside assignments about UAV technology requiring information beyond the textbook. Use of the Library's online databases such as Elsevier's ScienceDirect Database for academic journal articles.

**Sufficient Library Resources exist**

Yes

**Example of Assignments Requiring Library Resources**

Research, using the Library's print or online resources, the various uses and designs of UAVs in the military, in the police force, in the assessment and cleanup of environmental disasters, in the agriculture industry, etc.

**Primary Minimum Qualification**

ENGINEERING TECHNOLOGY

## Review and Approval Dates

**Department Chair**

10/30/2019

**Dean**

10/30/2019

**Technical Review**

11/07/2019

**Curriculum Committee**

11/19/2019

**DTRW-I**

12/12/2019

**Curriculum Committee**

MM/DD/YYYY

**Board**

01/21/2020

**CCCCO**

01/28/2020

**Control Number**

CCC000612480

**DOE/accreditation approval date**

MM/DD/YYYY