ARO 101
Intro-Aero

Introduction to Aeronautics

ARO 101 Sections 03 & 04

Sep 30, 2015 thru Dec 9, 2015

Instructor: Raymond A. Hudson

Week #1 Lecture Material

Three Questions For Everyone

1) By Show Of Hands: **HOW MANY PEOPLE IN THIS ROOM WANT TO BECOME AEROSPACE ENGINEERS?**

Moral: **COMMITMENT is the first step in achieving your dreams.**

2) By Show Of Hands: **HOW MANY PEOPLE HERE THINK THEY HAVE WHAT IT TAKES TO BECOME AEROSPACE ENGINEERS?**

Moral: **If you do not have CONFIDENCE in yourself, you are not likely to succeed.**

3) By Show of Hands: **HOW MANY PEOPLE HERE ARE WILLING TO DO WHAT IT TAKES TO BECOME AEROSPACE ENGINEERS?**

Moral: **COMMITMENT requires hard work. CAPITULATION is easy. Which one gets you what you want?**

Asking Questions Leads To Engineering Success!

- ***Notice from the last slide that I began this class by ASKING ALL OF YOU THREE QUESTIONS. This is to emphasize how important it is for your future as an engineer to ASK QUESTIONS!***
- ***LET GO OF YOUR EGO. STOP being afraid of "looking stupid," which inhibits you from asking questions you need answered:***
  1) *I am NOT going to make fun of you for asking.*
  2) *Anyone in this class that makes fun of someone for asking a question will be chastised, by me and other classmates.*
  3) *Chances are, when you ask a question, there are other people in the class who have the same question but are afraid to ask. You are doing more than yourself a favor!*
- ***I want each of you to formulate a question you have about aerospace engineering. When I take attendance, you will ask your question and I will do my best to answer it, if I can.***

About Me - Ray Hudson – CPPARO 1986

- *I am a Cal Poly ARO Engineering graduate – 1986. This means I know what you need to learn and I know the difficulty of this program! I AM HERE TO HELP YOU MAKE IT THROUGH!*
- *My background and experience are in aircraft flight control systems and complex systems engineering/architecture definition.*
  1) *General Dynamics (now Raytheon) Mark 31 Rolling Airframe Missile (RAM) Guided Missile Weapon System (GMWS) – Missile autopilot development & launch system integration with US Navy ship sensor systems.*
  2) *McDonnell-Douglas (now Boeing) MD-11 Automatic Flight Control System (AFCS) design, integration, & certification. Same roles for Boeing 717-200 (FKA MD-95). World wide field service activity.*
  3) *Northrop Grumman X-47B Unmanned Combat Air System-Demonstrator – Engine controls and throttle system development within the Vehicle Management System (VMS) group. System architect for various classified programs.*
- *This class is modeled after my knowledge of what you need to know to help you become an effective aerospace engineer.*

ARO 101
Intro-Aero

Textbook, Syllabus, Take Attendance

- ***Textbook:*** **Introduction To Flight**, *7th Edition (or later).* John D. Anderson, Jr. McGraw-Hill, ISBN 0-07-282569-3. 10 week syllabus shows which sections correspond to lecture material.
- ***Review the 10 week syllabus on the back of the handout. This is your map to the course, so you will always know where we are and what to expect! NO SURPRISES!*** (Well, except for those pop quizzes! ☺)
- ***As I take attendance:***
  1) *When your name is called, stand up, come get your "Learn-By-Doing Vehicle" (LBDV), and ASK YOUR QUESTION ABOUT AEROSPACE ENGINEERING.*
  2) *Assemble your LBDV and execute your own, personal, FIRST FLIGHT.*
  3) *Do you have any observations to share about your LBDV and its first flight?*
  4) *Everyone in the class congratulate (applause) the student for their FIRST FLIGHT!*
- **I WANT THIS CLASS TO BE FUN & INFORMAL. But talking while the instructor is teaching is disrespectful to me and to the other students who are trying to learn. RAISE YOUR HAND AND BE RECOGNIZED WHEN YOU HAVE SOME THOUGHTS TO SHARE WITH EVERYONE.**

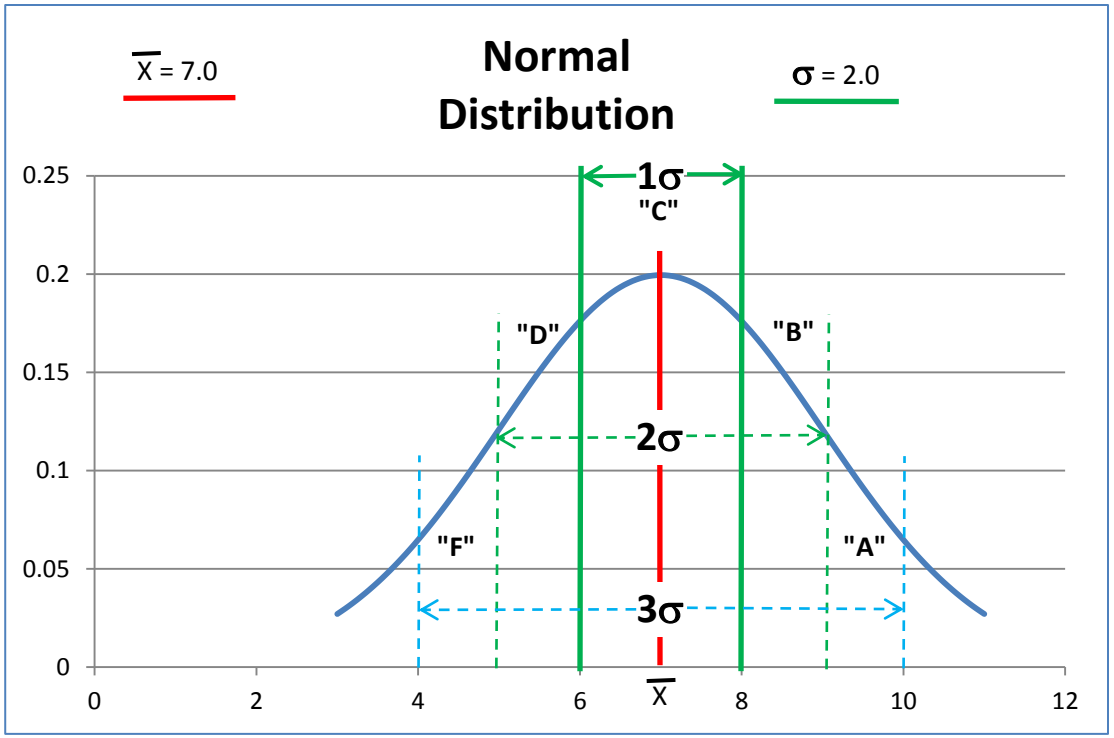
ARO 101
Intro-Aero

Grading Curve Computations

- *Course is based on a total of 100 points, with scoring opportunities as shown on the syllabus. (+Extra Credit)*
- *After each scoring opportunity, I will provide two numbers to quantify the grade statistics:*

X bar ($\bar{x}$) = Average of all scores
Sigma (σ) = Standard Deviation of all scores

- *I will provide X bar & Sigma for the scoring event, and the cumulative X bar & Sigma for all points thus far.*



- *The figure above shows how your score, along with X bar and Sigma, equates to a letter grade. You can always figure out where you stand in the class!*
- **If final class X bar > 70, straight curve applies**

Engineering Ethics – Because People Can Die

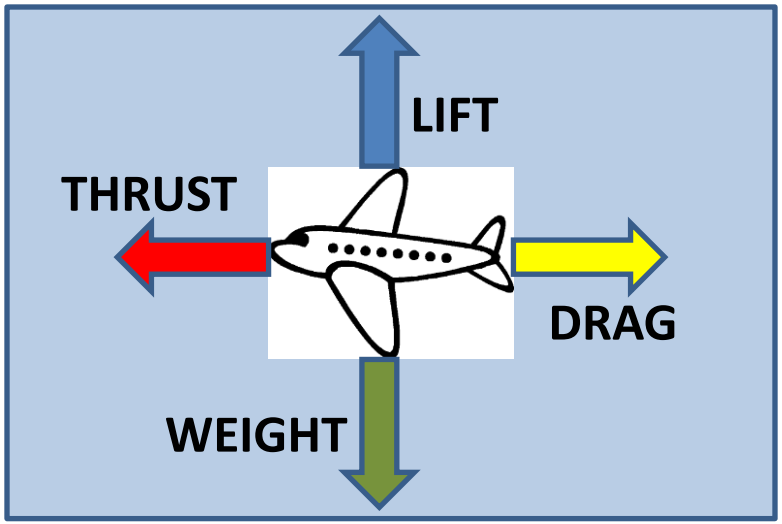
- ***In many professions, when someone acts unethically it "merely" results in someone losing money at the expense of those acting unethically.***
  - ***In our profession, people can lose their lives because someone acted unethically, or even carelessly!***
  - ***Even greater impact than in medical field. Because often in medicine you just cannot prevent someone's death. Preventing death is our job!***
- ***Students are expected to act ethically in this class!***
  - ***I do NOT tolerate academic cheating! You think you can get it past me? TRY ME! It could be the last mistake you make in your academic career!***
- ***Grading statistics*** *(X bar & Sigma)* ***are computed across two ARO 101 sections*** *(-03 Noon-3PM and -04 3PM-6PM)*
  - ***What this means to potential cheaters: Students from -03 section sharing quiz or test information with -04 section are only hurting themselves!***

ARO 101
Intro-Aero

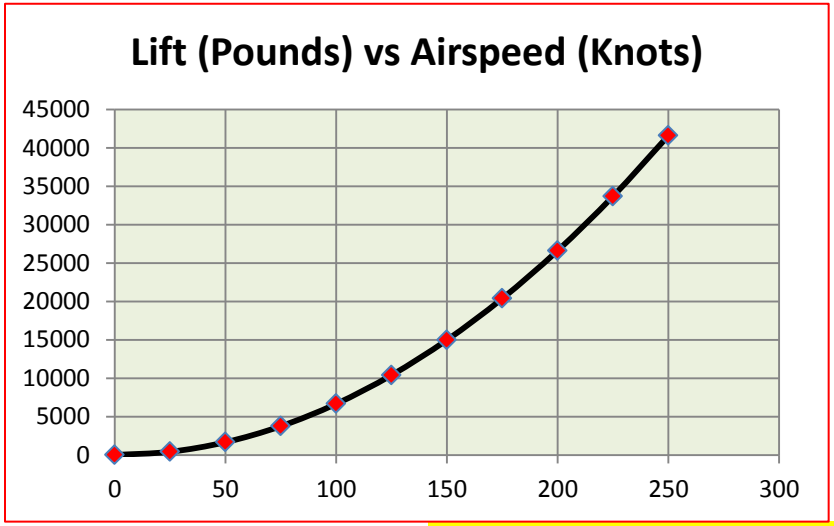
Basic Concepts Of Aerodynamics

(The "Magic" Is In The Squaring Of Airspeed!)

- ***When an airplane is flying in steady-state, un-accelerated flight, there is a balance of four forces:***



- ***The faster you fly*** *(airspeed, not ground speed!)****, the more lift (& drag!) you produce…squared!***



- **ALL AERODYNAMIC FORCES & MOMENTS (LIFT, DRAG, PITCHING MOMENT, etc.) ARE PROPORTIONAL TO DYNAMIC PRESSURE!**

Dynamic Pressure
(2 Variants)

$$\bar{q} = \tfrac{1}{2} * \rho * V^2$$
$$= \tfrac{1}{2} * \gamma * P * M^2$$

ARO 101
Intro-Aero

Systems Of Units & Ensuring Unit Consistency

The LARGE MAJORITY of mistakes made by freshman engineering students revolve around incorrect and/or inconsistent units!

- ✓ **Therefore, you should expect that I am going to challenge you with problems that consist of mixed and/or inconsistent units!**

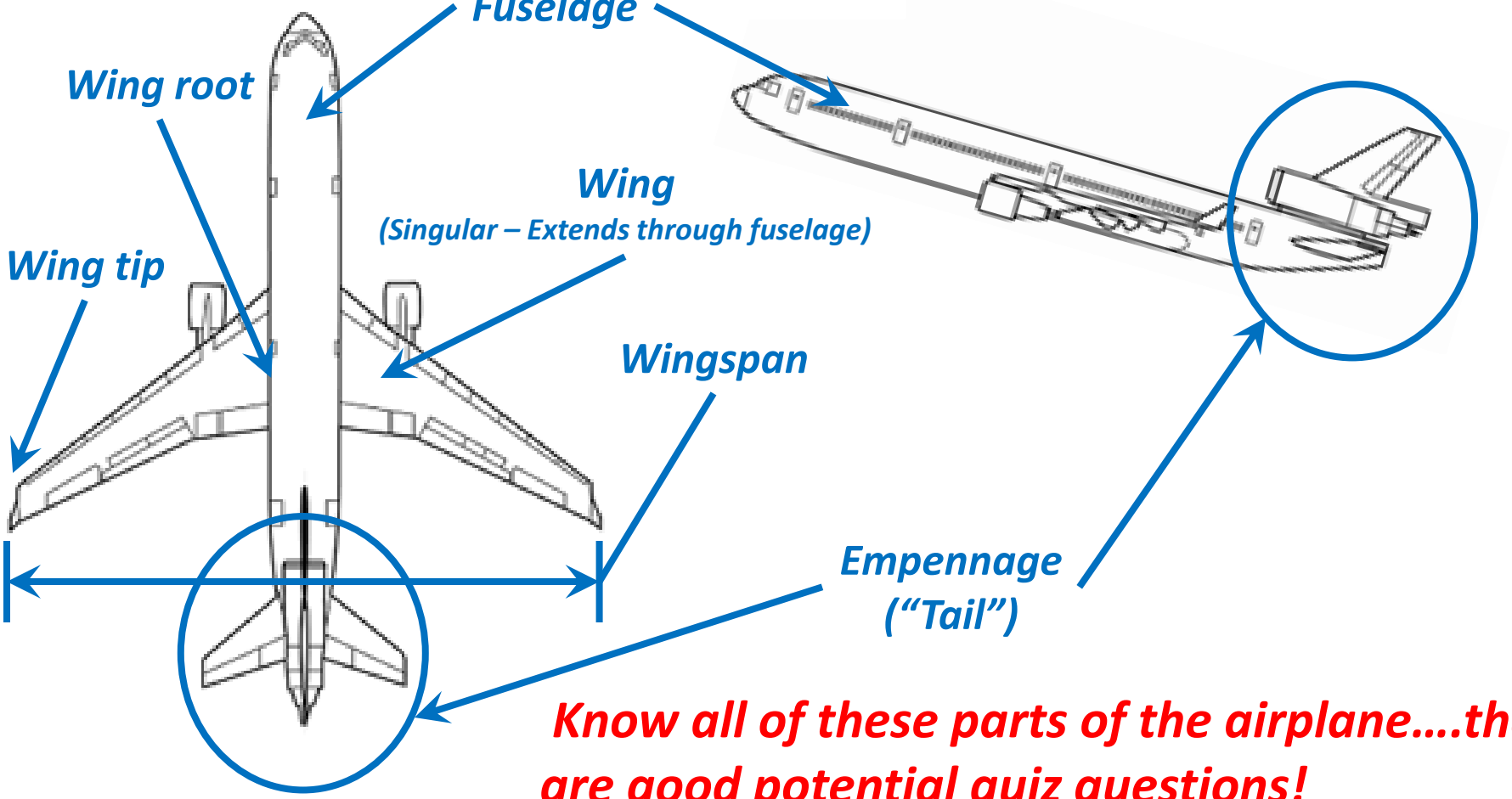
System	Mass	Length	Time	Force	Temp	Inconsistent!
British	Slug	Foot	Second	Pound	°Rankine	Pound-Mass X
SI	Kilogram	Meter	Second	Newton	°Kelvin	Kilogram-Force X

HUDSON'S RULES FOR SUCCESS FOR TAKING ENGINEERING EXAMS:

1) RELAX!!!
2) Draw a diagram of the problem.
3) MIND YOUR UNITS! Check them long hand!
4) SA+NA (Symbolic Answer AND Numeric Answer)
5) "Gut check" your final answer. Does it make sense?

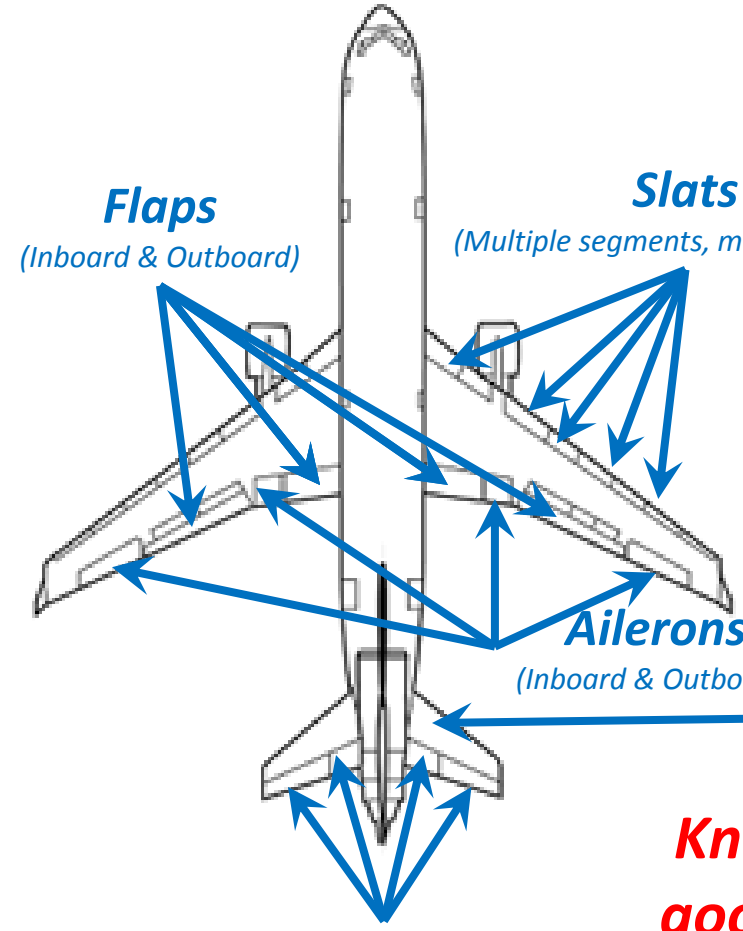
Anatomy Of A Conventional Airplane

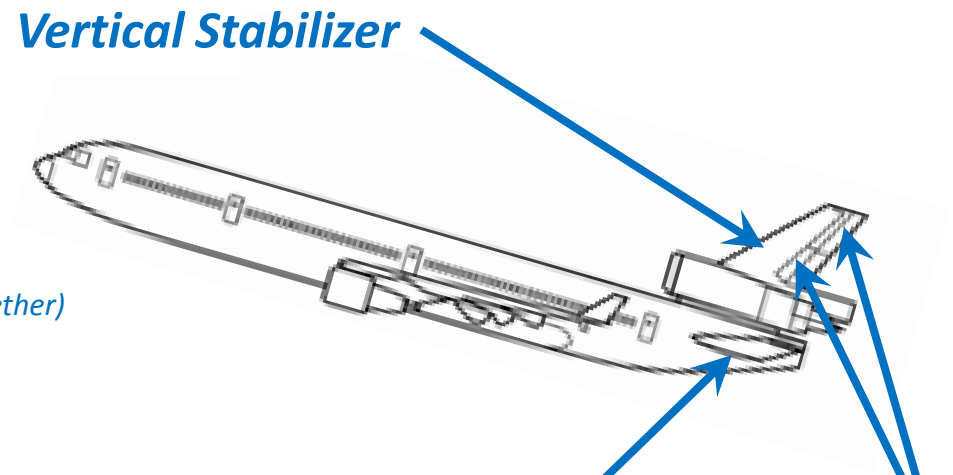
(This is an MD-11 BTW)



Know all of these parts of the airplane….these are good potential quiz questions!

Empennage Components & Control Surfaces





Know all of these parts & controls….these are good potential quiz questions!

The "Basic T" Primary Flight Instrument Cluster

ATTITUDE (Pitch & Roll)
"Artificial Horizon"

AIRSPEED

ALTITUDE

HORIZONTAL SITUATION INDICATOR

Know all four of these instruments and where they are located within the Basic T format.
Potential quiz questions!

History of Flight – Important Events

1) WHO WAS/WERE THE FIRST PERSON/PEOPLE TO ACHIEVE FLIGHT?

ANSWER: The Montgolfier Brothers (Hot Air Balloon – 1783)

2) WHO INVENTED THE CONVENTIONAL AIRCRAFT CONFIGURATION (WING+FUSELAGE+EMPENNAGE)?

ANSWER: Sir George Cayley (Model Glider – 1804)

3) WHO WAS/WERE THE FIRST PERSON/PEOPLE TO ACHIEVE CONTROLLED FLIGHT IN A CONVENTIONAL AIRCRAFT CONFIG?

ANSWER: Otto Lilienthal (Monoplane Hang Glider – 1891)

4) SO… THEN WHAT WAS THE MAJOR "FIRST IN KIND" EVENT FOR WHICH WILBUR & ORVILLE WRIGHT ARE CREDITED?

ANSWER: First Manned, Powered, Sustained, & Controlled, Heavier-Than-Air Flight (Dec 17th 1903)

A Compendium of Equations We Will Learn About & Use In This Course

Equations We Will Learn & Use - 1

Ideal Gas Law (Aerospace Version)

$$P = \rho * R * T$$

Dynamic Pressure (2 Variants)

$$\bar{q} = \tfrac{1}{2} * \rho * V^2$$

$$= \tfrac{1}{2} * \gamma * P * M^2$$

Speed Of Sound In a Fluid

$$a_{sos} = \sqrt{\gamma * R * T}$$

Mach Number

$$M = V_\infty / a_{sos}$$

Hydrostatic Equation [Pressure = f(depth)]

$$\Delta P = \rho * g * \Delta h$$ Finite Difference Eq.

$$dP = \rho * g * dh$$ Differential Eq.

Continuity Equation - Incompressible (Volumetric Flow Rate)

$$Q = A_1 * V_1 = A_2 * V_2$$

Continuity Equation - Compressible (Mass Flow Rate)

$$\dot{m} = \rho_1 * A_1 * V_1 = \rho_2 * A_2 * V_2$$

Equations We Will Learn & Use - 2

Pressure Coefficient

$$C_P = \frac{P_{LOCAL} - P_\infty}{\frac{1}{2}*\rho*V_\infty^{\,2}}$$

Lift-Curve Slope Equation (Linear Region ONLY)

$$C_L = C_{L_\alpha}*\alpha + C_{L_o}$$

Euler's Equation (Differential Form)

$$dP = -\rho*V*dV$$

Bernoulli's Equation (Steady, Level, Incompressible Flow ONLY)

$$P_1 + \frac{1}{2}*\rho*V_1^{\,2} = P_2 + \frac{1}{2}*\rho*V_2^{\,2}$$

Equations We Will Learn & Use - 3

Lift Coefficient (2-D Airfoil)

$$C_l = \frac{\text{LIFT Force}}{\frac{1}{2}*\rho*V^2*c}$$

Lift Coefficient (3-D Wing)

$$C_L = \frac{\text{LIFT Force}}{\frac{1}{2}*\rho*V^2*S_{REF}}$$

Drag Coefficient (2-D Airfoil)

$$C_d = \frac{\text{DRAG Force}}{\frac{1}{2}*\rho*V^2*c}$$

Drag Coefficient (3-D Wing)

$$C_D = \frac{\text{DRAG Force}}{\frac{1}{2}*\rho*V^2*S_{REF}}$$

Pitching Moment Coefficient (2-D Airfoil)

$$C_m = \frac{\text{PITCH Moment}}{\frac{1}{2}*\rho*V^2*c^2}$$

Pitching Moment Coefficient (3-D Wing)

$$C_M = \frac{\text{PITCH Moment}}{\frac{1}{2}*\rho*V^2*S_{REF}*\bar{c}}$$