CALCULUS 152, SPRING 2015
GROUP PROJECT

Due Friday, 1 May 2015 (M38) by 1530

Your submission must be a coherent, succinct, and professionally presented stand-alone product. Use appropriate technology to embed diagrams, tables, graphs, charts, and equations. Neatness and completeness are fundamental to developing a logical thought process and communicating effectively. There is no maximum page count, but you should not add superfluous material to extend the length of your report.

GROUP STRUCTURE:
Your groups will be composed of 2-4 members. The group composition will be at the discretion of your instructor. All members of the group are responsible for development of the solutions.

GRADING:
The group project is worth 100 points per team member. Each team member will receive the team score.

AUTHORIZED RESOURCES:
Anyone and anything with the following exceptions/clarifications:
1. You may NOT receive help from current Calc-152 students outside your group.
2. Your group must prepare and submit its own work.

DOCUMENTATION:
All external assistance and all resources referenced must be properly documented IAW the Dean's "Academics with Honor" letter, the "DFMS Documentation Policy Letter," and the Honor Code Reference Handbook.

EI POLICY:
Schedule EI only after making a reasonable attempt to research the material on your own. You may receive EI from either the QRC or a DFMS instructor, depending on availability.

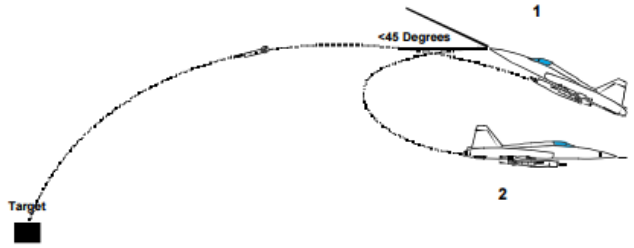
Problem 1

a) (**20 points**) After it is released from an aircraft, a GBU-12 follows a ballistic trajectory prior to the acquisition of a laser signal and initiation of guidance. Assume the ordnance experiences zero acceleration in the horizontal direction and only acceleration due to gravity in the vertical direction (assume no drag and wind). For each of the scenarios described below 1) develop an equation to describe the ballistic trajectory in the horizontal and vertical axes, 2) calculate the time of fall, 3) calculate the distance each GBU will travel after release, and 4) calculate the impact angles (degrees). Plot the three trajectories on a single xy-graph for comparison. Use tables similar to those below for data presentation in your paper.

Scenario 1: An MQ-9 flying 150 KTAS* at 25,000 MSL* drops a GBU-12 to hit a target at 5,000 MSL
Scenario 2: An A-10 flying 350 KTAS at 15,000 MSL drops a GBU-12 to hit a target at 5,000 MSL
Scenario 3: An F-16 flying 550 KTAS at 20,000 MSL drops a GBU-12 to hit a target at 5,000 MSL

Scenario	Equation of Trajectory	Time of Fall	Distance	Impact Angle (Degrees)
1: MQ-9				
2: A-10				
3: F-16				

b) (**15 points**) JDAMs allow improved accuracy when released by means of a "loft" or "toss" delivery. Assume a JDAM is released using a loft delivery angle of 10, 20 and 40 degrees above the horizon from 500 feet AGL* and 550 KTAS. For each of the three loft angles, decompose the velocity vector of the JDAM into its vertical and horizontal components to plot the three profiles on a single graph. Use the graph to determine the ballistic range and time of flight for each of the three loft delivery angles. Assume no-wind and no-drag. Use tables similar to those below for data presentation in your paper.



Scenario 550KTAS 500AGL	Equation of Trajectory	Time of Flight/Fall	Distance Traveled from Release
Level			
+10deg			
+20deg			
+30deg			

*MSL = feet above Mean Sea Level.
AGL = feet Above Ground Level.
KTAS = True Airspeed (knots) is the speed at which an aircraft is moving relative to the surrounding air (nm/hr).
Use 1nm = 6000ft

Problem 2

The SS Minnow, an experimental Littoral Combat Ship sank off of a previously uncharted desert island during a three-hour shake-down cruise, on a ridge between 30 and 120 feet. **Determine whether an underwater demolition team will be able to complete the proposed dive profile (below) to enter the ship, reach the engine room, secure the nuclear fuel rods and return safely.**

To assist in developing your solution, first answer the following questions:

a) (**5 points**) At sea-level, the atmospheric pressure is 1-atmosphere (1 atmosphere = 101325Pa. 1 $Pa = 1\ Newton/m^2$). Assuming a constant temperature, Boyle's Law tells us $P_1V_1 = P_2V_2$ (P = Pressure and V = Volume). Using this relationship, how much volume will one (1) liter of Sea-Level-Pressure air, occupy at 2, 3, 4 & 5 atmospheres of pressure?

b) (**5 points**) $P_{total} = P_{atmosphere} + P_{fluid}$. Given a sea-water density of 1032 kg/m^3, at what depths will the hydrostatic pressure create an additional 1, 2, 3 & 4 atmospheres of pressure?

c) (**5 points**) A 15 liter tank pressurized to 2700psi contains how many liters of SLP air? (3447379 Pa = 500 psi)

d) (**5 points**) 2000 liters of SLP air compressed into 15 liters will require how much pressure (psi)?

e) (**5 points**) Upon reaching the depth of **32 m,** securing the fuel rods will require moderate intensity exertion. To not exceed a respiration rate of **40bpm** (breathes per minute), the rate of force application ("dF/dt") is directly proportional to the collective force ("= k F") of the team-members' 10-rep maximum bench press. Crews with a collective force of 100 lbs can complete the task in 10 minutes, while crews with a collective force of 500 lbs can complete the task in 3 minutes. Derive both **t(F)** and **F(t)**.

Now, **determine whether or not a team will be able to accomplish the proposed dive profile**. Use an average breath volume of **10 milliliters per kilogram of body mass** at **20 breaths per minute** (bpm) for normal swimming, and **40 bpm** for moderate intensity exertion.*

(**20 points**) The demolition team consists of one 80 kg diver with a 13.2L tank and a 90 kg diver with a 15L tank. Their collective 10-rep max is 315 lb. All tanks start with a pressure of 2700psi. The team conducts all ascents & descents at 4m/min.

DIVE PROFILE:

Descend along the anchor line to the hatch at **12 meters**.

Swim **10min** at **12 meters** until main corridor

Descend to **32 m** for **t(315 lbs) minutes**, breathing at **40 bpm**.

Return to **12 meters** for 10min to return the hatch

Remain for **5 minutes** at **4m** to denitrogenate

Surface with at least **200psi**

In one-minute intervals, scale the plot of the dive profile and expected tank pressures to fit on a single graph (TIP: you might find it helpful to plot your dive profile in terms of atmospheres).

If the expected pressure in the tank is above the required 200psi at profile completion, calculate how much longer the team could remain on the task at 32m.

(**20 points**) **Given two 13.2L, and one 15L dive tanks, can YOUR project team complete the profile?**

*At rest, we breathe 12 to 16 times a minute, with the volume of each breath averaging 6 to 8 milliliters (ml) per kilogram (kg) of body mass. Moderate intensity exertion will normally increase your respiration to 30 breaths per minute, but the human performance lab recommends breathing more deeply and regulating your breathing.