Project 3
Project 3 Objectives

At the end of this project, you should be able to:

• control the speed and direction of DC motors through an H-bridge circuit,

• implement and tune a proportional-derivative control law that maintains the hovercraft's heading at some desired orientation, and

• implement a high-level control law that decides when to brake and when to use the PD control law.
Part 1: Circuit

- Mount motor amplifier board
- Connect ducted fans to the output side
- Connect microprocessor to the input side
- Keep away from the compass
Part 2: Fan Control Interface

Must implement:

• void set_middle_direction(MotorDirection direction)
  – Determines whether the middle fan is pushing air into or out of the chamber

• In project.h, define:

  typedef enum {
    BRAKE,          
    HOVER          
  } MotorDirection;

  – This new data type has two values: BRAKE and HOVER
Part 2: Fan Control Interface

Must implement:

- `void set_middle_magnitude(int16_t magnitude)`
  - Sets the duty cycle of the middle fan. Must ensure that `magnitude` is in the range `[0 ... 1023]`

- `void set_lateral_magnitudes(int16_t magnitude_left, int16_t magnitude_right)`
  - Sets the duty cycle of the left and right fans. Must ensure that the magnitudes are in the valid range

- `Initialization of the PWM channels (more on this today)`
Part 3: Proportional-Derivative Control

Must implement:

- `void pd_control(int16_t error, int16_t rotation_rate, uint16_t forward_thrust)`
  - Implements the PD-control law: compute a left/right differential
  - Add this differential to `forward_thrust` to derive duty cycle signals for the left/right fans
  - Use the computed duty cycles to set the fan speed

Note: test slowly
Part 4: Main Program

• Start with the template in the project specification and fill in your own code as necessary

• The interrupt service routine sets the flag_timing variable to 1 every 49.152 ms
  – This allows us to ensure that we have ~20 control cycles per second.
Part 5: Hovercraft

• Mount the motor amplifier board
• Connect the board to the batteries (motor power pins only - not the logic pins!)
• No wires near the fans
Checkpoint

• 30 minute meeting within one week
• Have much of parts 1-3 completed and tested
• A successful checkpoint is worth 10% of the project grade