Semester 2 Final Study Guide

Best Way to Study

- Review:
  - MyPLTW modules
  - Slides
  - Activities
  - Projects
- Use the Engineering Formula Sheet (provided on test)

Unit: Electricity

Key Topics & Components

- Breadboarding & Circuits
- Fun with Digital Electronics
- Schematics (reading & drawing)

Important Components

- Resistor
- Capacitor
- Diode
- LED
- Switch
- Transistor
- L7805 Voltage Regulator
- 555 Timer
- IC (Integrated Circuit)
- DIP Switch
- 7-Segment Display

Tools & Equipment

- Breadboard
- Jumper Wires
- Multimeter
- DC Power Supply

Key Concepts

- Ground
- Float (undefined state)
- RC (Resistor-Capacitor) Circuits
- Blinking LED Circuit (Astable Multivibrator)

Digital Logic

- Logic Gates:
  - AND
  - NAND
  - OR
  - NOR
  - XOR
  - NOT
- Latch / Flip-Flop (memory in circuits)

Unit: Aerospace

Orbits & Gravity

Key Concepts

- Gravity = force pulling objects together
- Depends on:
    - Mass ↑ → Gravity ↑
    - Distance ↑ → Gravity ↓

Orbits

- Objects are constantly falling around Earth
- Caused by:
    - Forward velocity
    - Gravity pulling inward

Know

- More speed → higher/wider orbit
- Too slow → falls to Earth
- Too fast → escapes gravity

Rocket Propulsion & Escape

Newton's 3rd Law

- Action: exhaust pushed down
- Reaction: rocket pushed up

Rocket Engines

- Fuel + oxygen → combustion → thrust
- Work in space because they carry oxygen

Escape Velocity

- Minimum speed to escape Earth: ~11.2 km/s

Space Travel: The Big Picture

- Rockets → get you to space
- Orbits → keep you there
- Transfers → move you between locations

Key Idea

- Space travel uses curved paths, not straight lines
- Engineers focus on fuel efficiency

Apollo Moon Mission

Mission Steps

1. Launch
2. Earth orbit
3. Transfer to Moon
4. Lunar orbit
5. Landing
6. Return

Engineering Challenges

- Limited fuel
- Weight constraints
- Precise timing

Big Idea

- Engineering = trade-offs + planning

Atmosphere & Flight

Atmosphere

- Air density ↓ as altitude ↑
- Lower density → less lift

Four Forces of Flight

- Lift ↑
- Weight ↓
- Thrust →
- Drag ←

Balanced Flight

- Lift = Weight
- Thrust = Drag

Flight Optimization

Goal

- Maximize lift
- Minimize drag
- Improve efficiency

Variables Engineers Adjust

- Wing shape
- Speed
- Angle of attack
- Surface design

Trade-Offs

- More lift → more drag
- More speed → more drag

Lift, Angle of Attack, & Stall

What Affects Lift

- Velocity (biggest effect)
- Air density (ρ)
- Wing area (A)
- Lift coefficient (CL)

Angle of Attack (AoA)

- Angle between wing and airflow
- Increasing AoA → increases lift (initially)

Stall

- Occurs at high AoA
- Airflow separates from wing
- Lift drops suddenly

Graph Skills

- Lift increases → peaks → drops
- Peak = stall point

Be Able To

- Read lift vs AoA graphs
- Identify:

    - Maximum lift
    - Stall angle
- Compare airfoils

VTOL (Vertical Takeoff and Landing)

What It Is

- Aircraft that can:
    - Take off vertically
    - Land vertically
    - Hover

Examples

- Helicopter
- Harrier Jet
- F-35B

How It Works

- Thrust directed downward
- Push air down → aircraft goes up (Newton's 3rd Law)

Compare Traditional Aircraft with VTOL

- Runway
- Lift Source
- Efficiency
- Hover

Trade-Offs

- Uses more fuel
- More complex
- Less efficient

Unit: Control Systems

VEX Coding

Core Concepts

- Comments → explain code (not executed)
- "When Started" → program entry point

Loops

- while → repeats while condition is true
- forever → runs continuously
- wait → pauses for time
- wait until → pauses until condition is met

Conditionals

- if → then → else
- Nested conditionals

Variables

- Types (number, boolean, etc.)
- set → assign value
- change → modify value

Output

- print → display text
- Clear brain screen

Functions

- Reusable blocks of code
- Used to organize and simplify programs

VEX Hardware

Motors & Sensors

- Motor vs Servo:
    - Motor → continuous rotation
    - Servo → controlled position

Sensors

- Bumper / Limit Switch → digital (on/off)
- Distance Sensor:
    - Measures distance (~inches)
    - Can estimate size & speed
- Optical Sensor:
    - Detects brightness, color (hue), proximity
- Potentiometer:
    - Measures rotation/angle

Brain

- Controls robot
- Runs code
- Connects all components

Ports

- Smart Port vs 3-Wire Port

Setup

- Battery → cable → brain → motors/sensors
- Proper connections are critical

Flowcharts

Know

- Common symbols:
    - Start/End
    - Process
    - Decision
    - Arrows (flow direction)

Skills

- Read flowcharts
- Interpret logic and sequence