INTEGRATING DRONES INTO CURRICULUM FOR ACADEMIC EXCELLENCE

FUTURE LEARNING

IN OMNIA PARATUS
INDUS TRUST

AEROHAWX
CREATED BY INDUS

SCHOOL IOX
CREATED BY INDUS

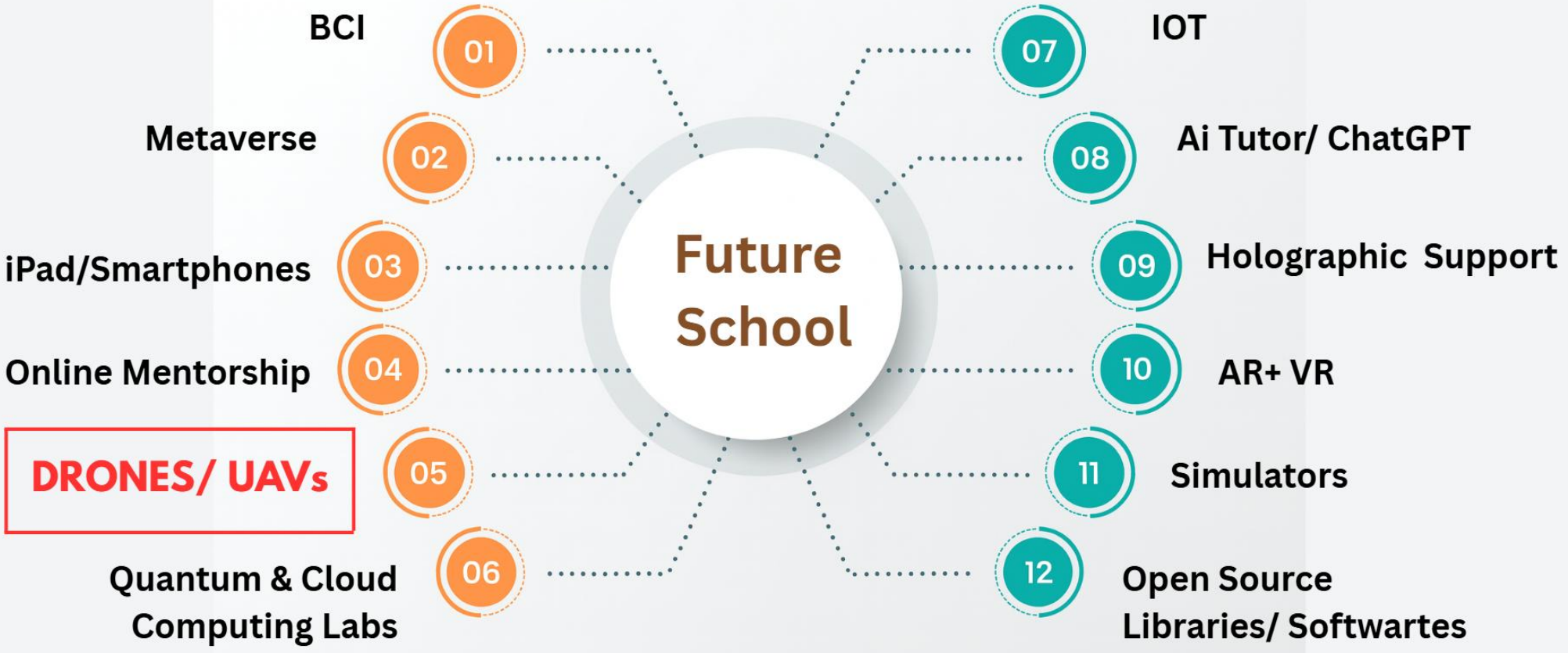
SEPTEMBER , 2025

DEPARTMENT OF TECHNOLOGY AND RESEARCH
INDUS TRUST, BANGALORE

IN OMNIA PARATUS
INDUS
TRUST

DEPARTMENT OF
TECHNOLOGY AND
RESEARCH

Integrating Drones into Curriculum for Academic Excellence


Future School
01
BCI
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Metaverse
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iPad/Smartphones
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Online Mentorship
DRONES/ UAVs
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Quantum & Cloud Computing Labs
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IOT
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Ai Tutor/ ChatGPT
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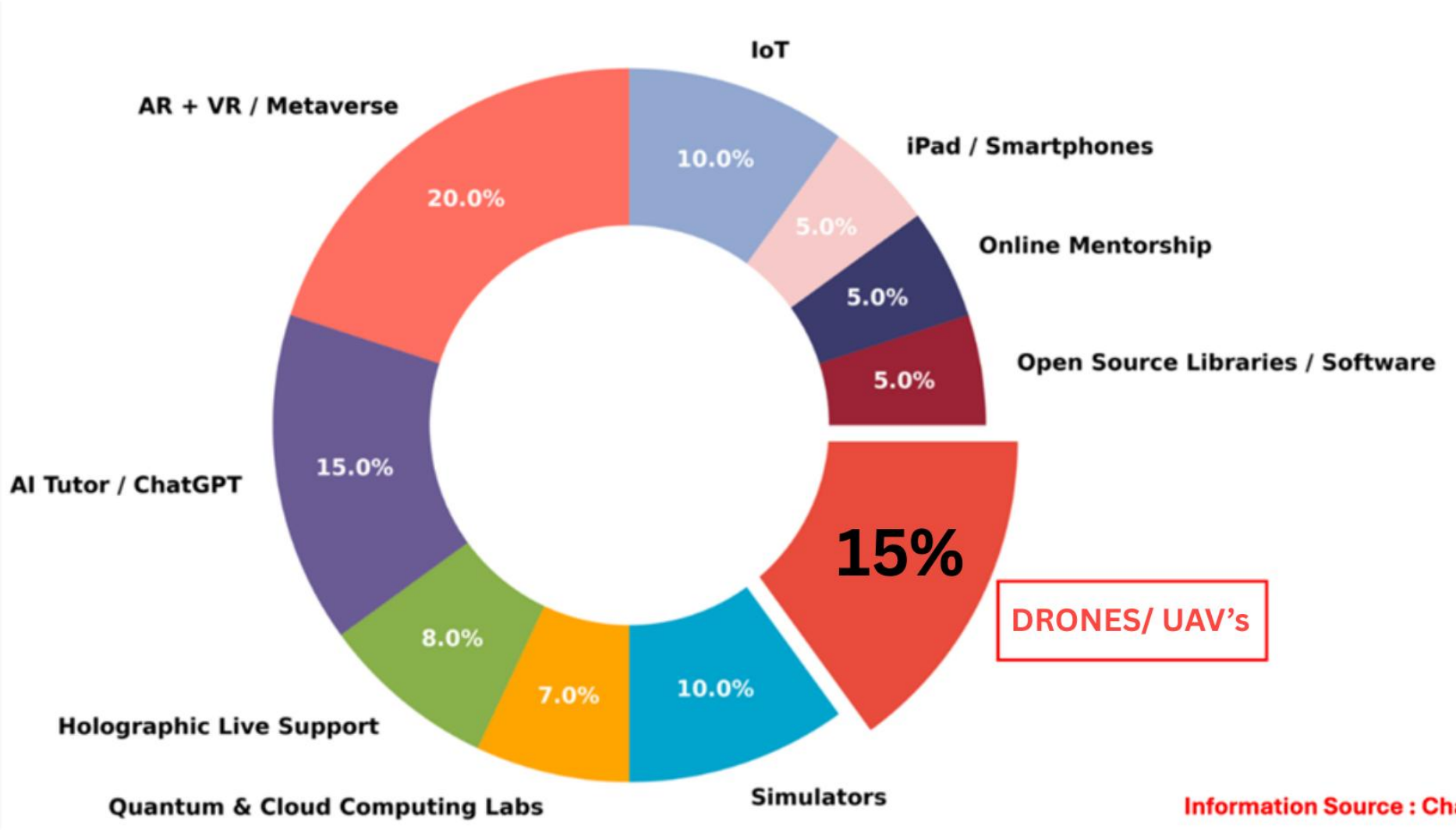
Holographic Support
10
AR+ VR
11
Simulators
12
Open Source Libraries/ Softwartes

FUTURE TECHNOLOGY CURRICULUM INTEGRATION
[Grades 9-12]



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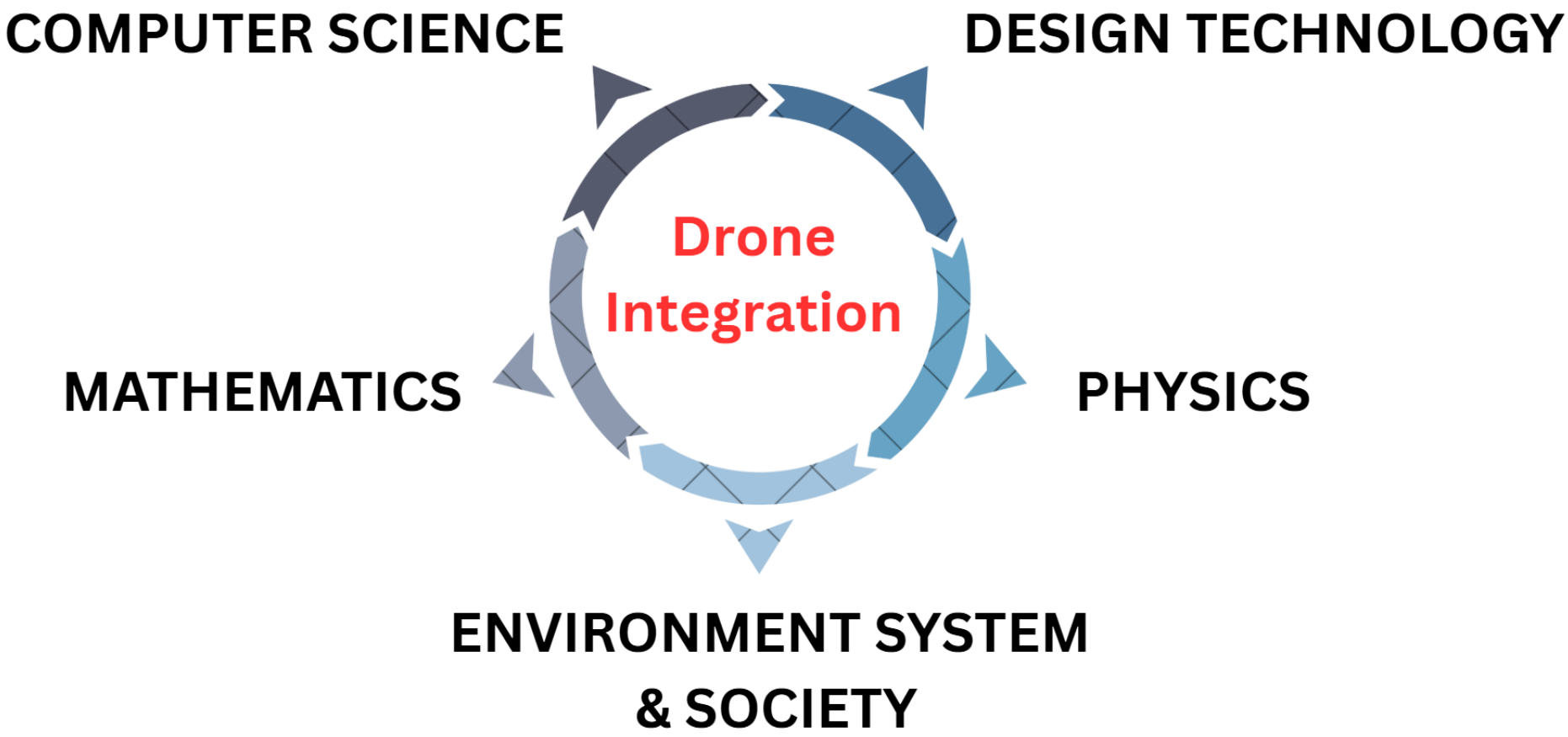
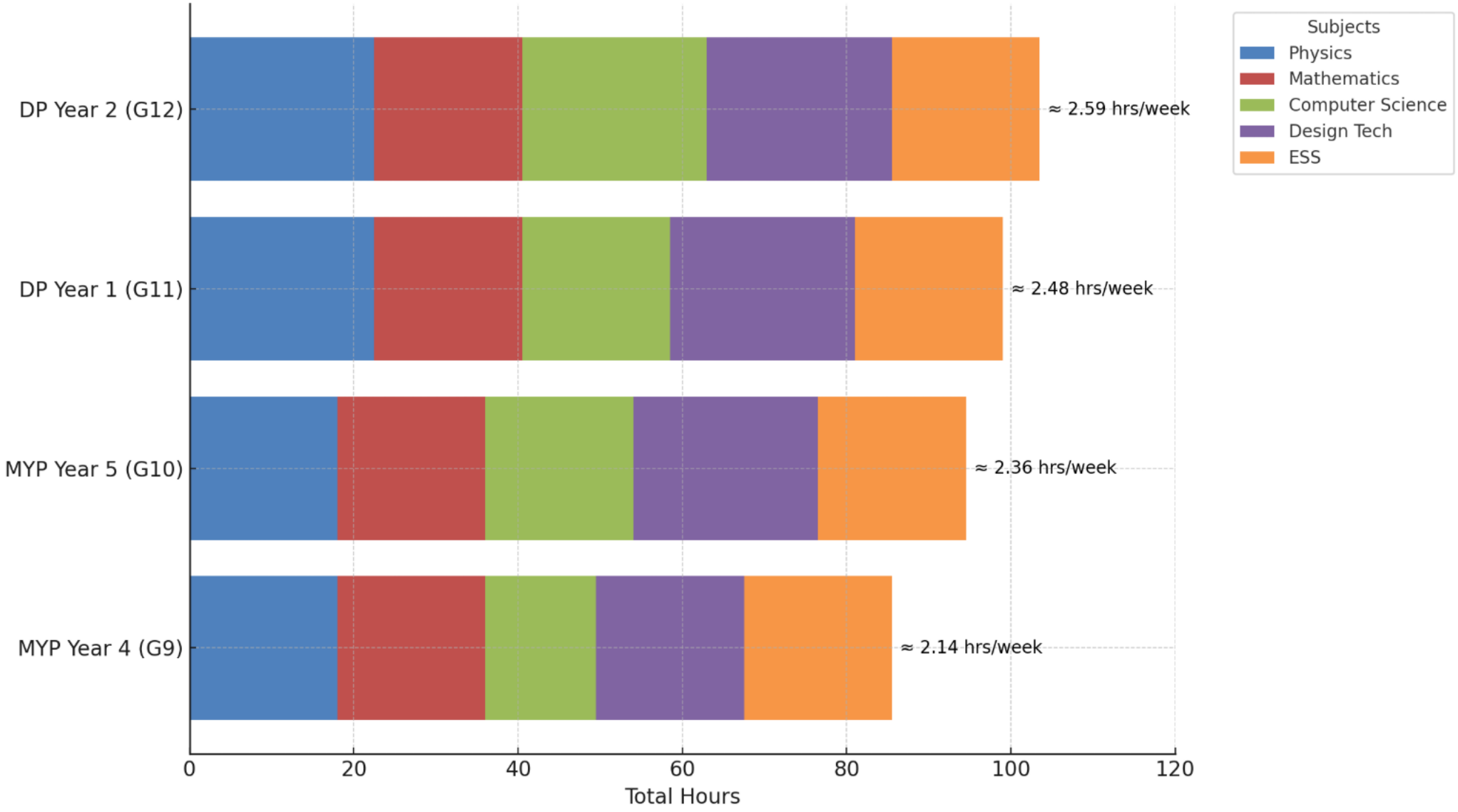
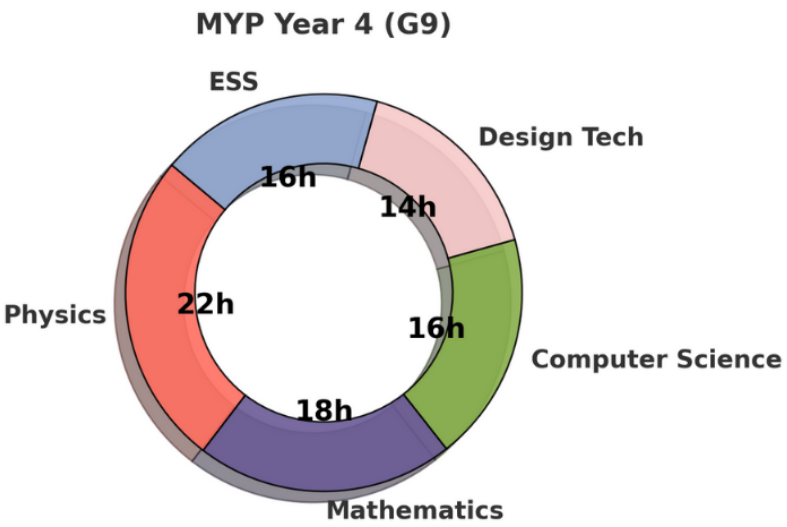
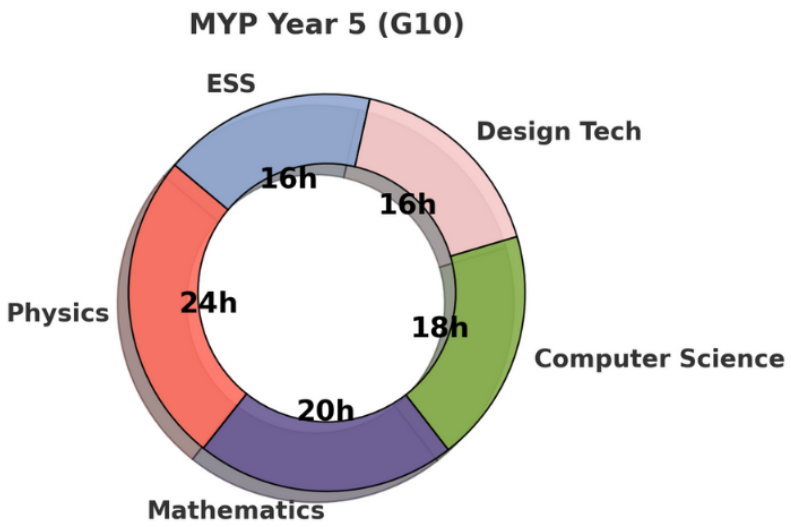

COMPUTER SCIENCE
DESIGN TECHNOLOGY
Drone Integration
MATHEMATICS
PHYSICS
ENVIRONMENT SYSTEM & SOCIETY

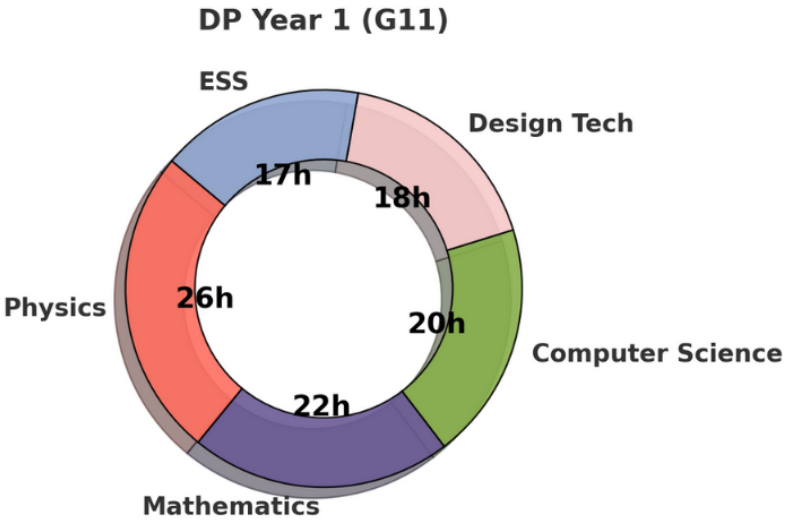
Time Distribution Grade-Wise

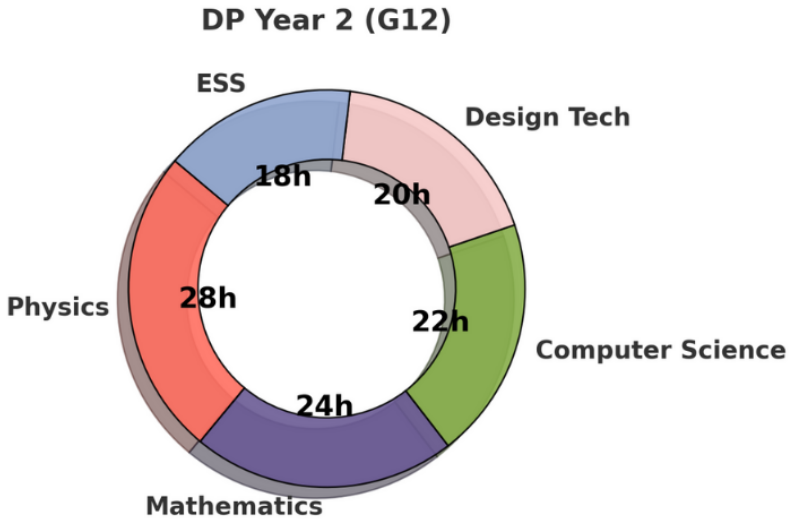


Subject Distribution (Yearly Hours)

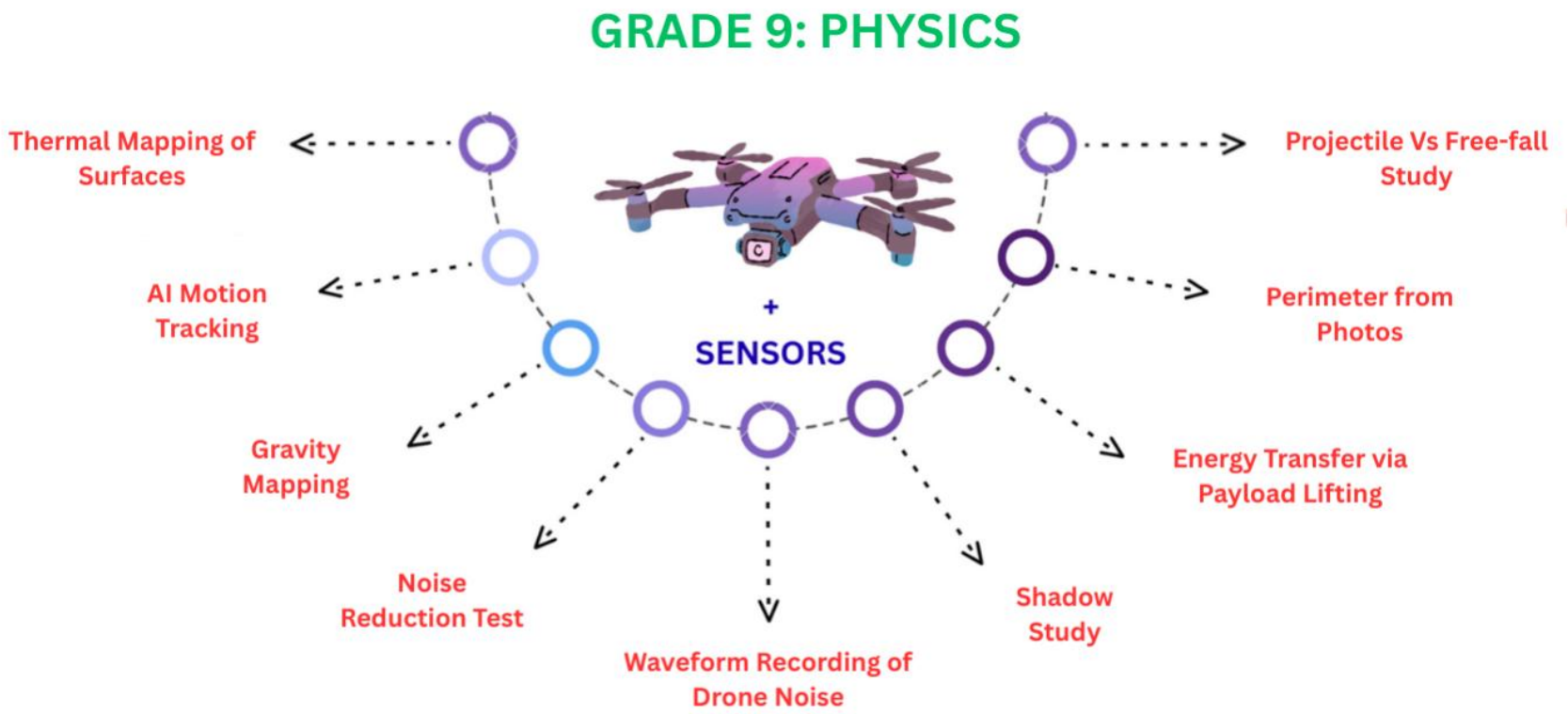








MYP Year 4

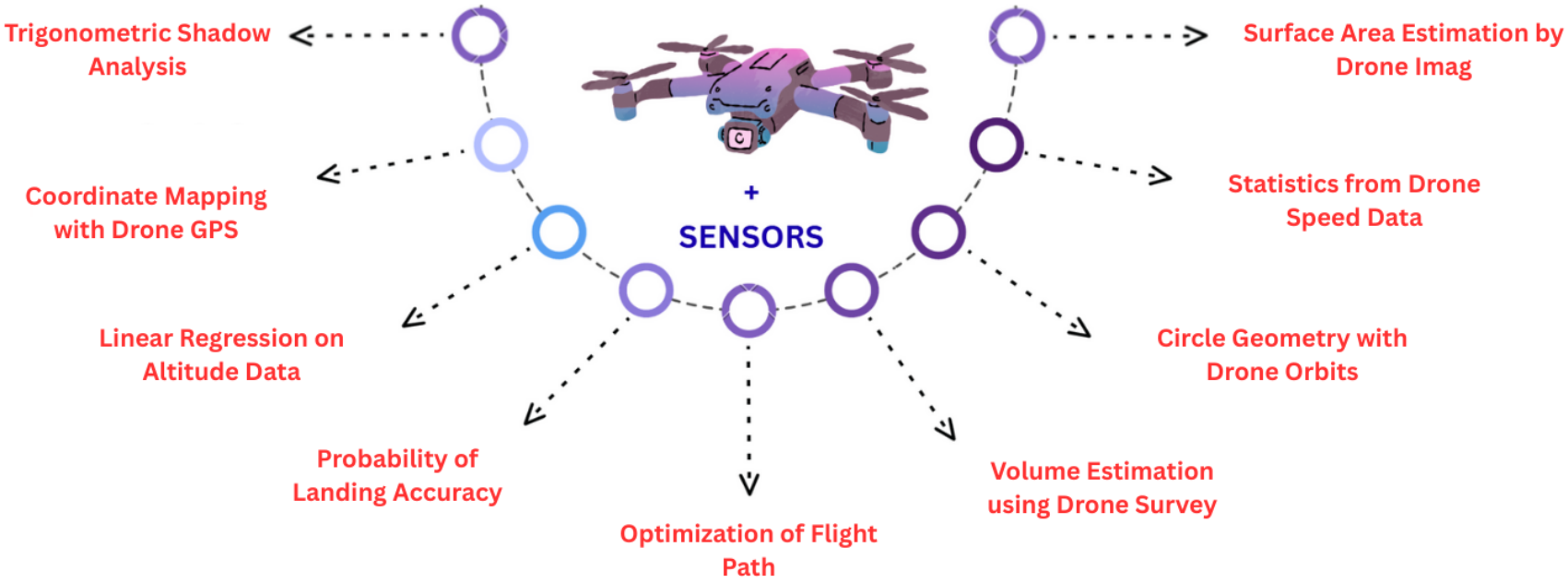

GRADE 9: PHYSICS
Thermal Mapping of Surfaces
AI Motion Tracking
Gravity Mapping
Noise Reduction Test
Waveform Recording of Drone Noise
Shadow Study
Energy Transfer via Payload Lifting
Perimeter from Photos
Projectile Vs Free-fall Study
+
SENSORS

Physics

Activity Name	Detailed Description	Curriculum Link	Time Required
AI Motion Tracking	Use drone + camera/AI vision to track a moving student or rolling ball. Students collect displacement, velocity, acceleration data → plot motion graphs.	Physics – Kinematics (motion graphs, displacement, velocity, acceleration)	~2 hrs (30 min setup, 1 hr flight & data collection, 30 min graph plotting)
Gravity Mapping	Use drone + barometric sensor to measure altitude changes. Students calculate and compare gravitational acceleration (g) at different heights.	Physics – Gravitation (acceleration due to gravity)	~2 hrs (20 min setup, 1 hr data collection, 40 min calculations)
Package Drop Accuracy	Students calculate the exact drop timing by considering drone speed, target speed, wind speed, and altitude.	Physics – Projectile Motion (range, time of flight)	~2.5 hrs (30 min setup, 1 hr flight trials, 1 hr calculation & analysis)
Noise Reduction Test	Swap different propeller types on the drone. Measure sound levels using a decibel meter → link to amplitude & pitch.	Physics – Sound (amplitude, frequency, wave properties)	~1.5 hrs (20 min setup, 40 min trials, 30 min analysis)
Shadow Study	Hover drone at fixed altitude at different times of day. Measure shadow length → calculate Sun's angle using trigonometry.	Physics + Math – Light (shadows, Sun's motion), Trigonometry (tan θ applications)	~1.5 hrs (excluding gaps between time-of-day trials)
Hover Stability Test	Record drone altitude variation during hover. Use data to analyze forces in equilibrium (lift = weight).	Physics – Forces & Equilibrium	~1.5 hrs (15 min setup, 45 min trials, 30 min analysis)
Circular Flight Force	Fly drone in circular path. Students calculate centripetal force from radius & velocity data.	Physics – Circular Motion	~2 hrs (20 min setup, 1 hr flight & data logging, 40 min calculations)

Battery Efficiency Study	Record drone flight time under hover vs forward flight. Compare energy efficiency and calculate power usage.	Physics – Work, Energy & Power	~2 hrs (30 min setup, 1 hr trial flights, 30 min analysis)
Sound Propagation Test	Place microphones at different distances from drone. Measure intensity to verify inverse square law.	Physics – Waves & Sound	~2 hrs (20 min setup, 1 hr data collection, 40 min analysis)

GRADE 9: MATHEMATICS

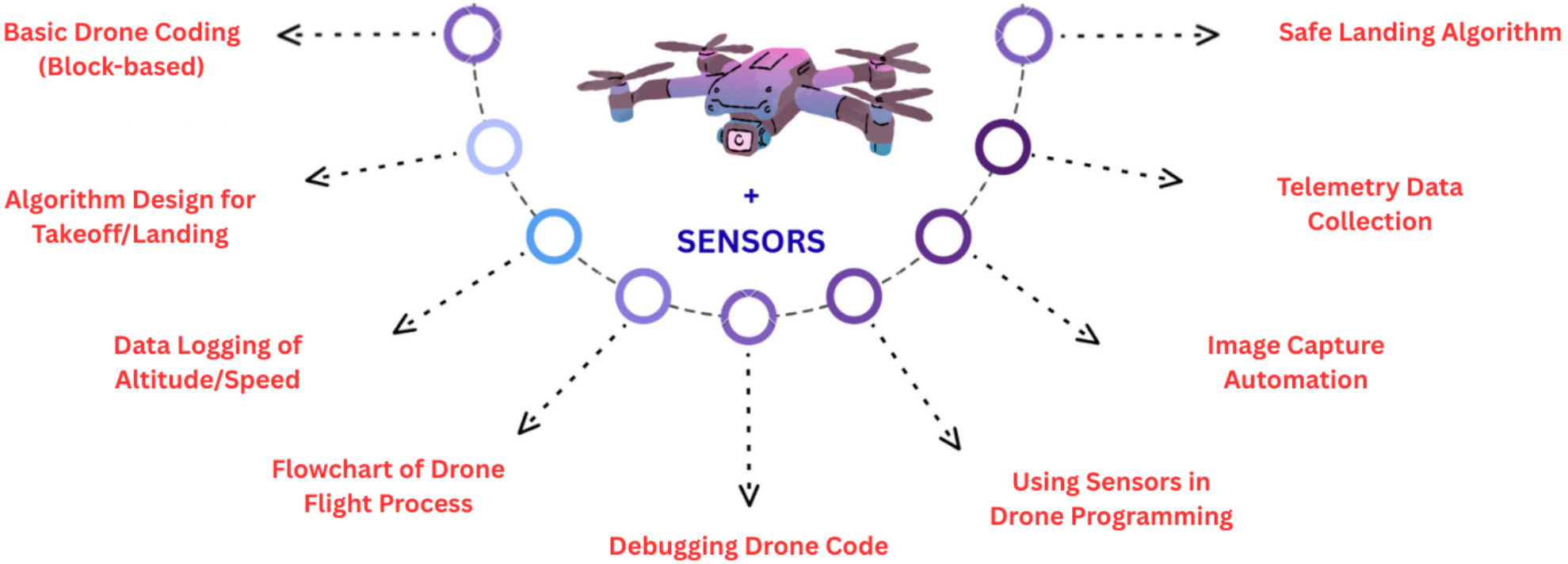


Mathematics

Activity Name	Detailed Description	Curriculum Link	Time Required
Quadratic Flight Paths	Program drone to ascend and descend. Collect altitude vs time data, fit quadratic equation, identify vertex (max height).	**Algebra – Quadratic functions (parabolas, vertex form)**. Criterion C: Communicating	~2 hrs (30 min setup, 1 hr flights, 30 min analysis)
Trigonometric Distance	Hover drone at 10m. Use angle of depression from ground observer to calculate horizontal distance using tan θ. Verify by measurement.	**Geometry & Trigonometry – Right-triangle trig, applications**. Criterion A: Knowing & Understanding	~1.5 hrs (20 min setup, 40 min trials, 30 min verification)
Battery Decay Curve	Record battery % every minute. Plot exponential decay model, calculate half-life of charge.	**Functions – Exponential functions, growth & decay models**. Criterion C: Communicating	~2 hrs (15 min setup, 1 hr data logging, 45 min modeling)
Landing Probability	Attempt 20 landings on a marked pad. Record successes vs failures. Compute experimental probability.	**Statistics & Probability – Experimental vs theoretical probability**. Criterion B: Inquiring & Designing	~1.5 hrs (20 min setup, 40 min trials, 30 min analysis)
Flight Altitude Statistics	Conduct 10 flights at varying heights. Calculate mean, median, mode, standard deviation. Display in boxplot.	**Statistics – Data handling & measures of central tendency/dispersion**. Criterion C: Communicating	~1.5 hrs (20 min setup, 40 min flights, 30 min graphing)
Route Optimization	Define drone delivery problem with constraints (time ≤ 15 min, 3 waypoints). Solve using inequalities and graphical method.	**Algebra – Linear programming & inequalities**. Criterion D: Applying mathematics in real-life contexts	~2.5 hrs (30 min setup, 1 hr modeling, 1 hr solution)

Coordinate Mapping	Drone records GPS coordinates. Students plot in Cartesian plane, calculate distances & area enclosed.	**Geometry – Coordinate geometry & distance formula**. Criterion A: Knowing & Understanding	~1.5 hrs (20 min setup, 40 min mapping, 30 min analysis)
Flight Path Transformations	Program square flight path. Apply reflections and translations on plotted coordinates. Compare with real drone data.	**Geometry – Transformations (reflections, translations, rotations)**. Criterion B: Inquiring & Designing	~2 hrs (30 min setup, 1 hr plotting, 30 min analysis)
Irregular Plot Mensuration	Capture aerial image of school ground. Use trapezoidal rule on overlaid grid to approximate area.	**Geometry – Mensuration & approximation of irregular shapes**. Criterion D: Applying mathematics in real-life contexts	~2 hrs (20 min setup, 1 hr data collection, 40 min calculations)

GRADE 9: COMPUTER SCIENCE

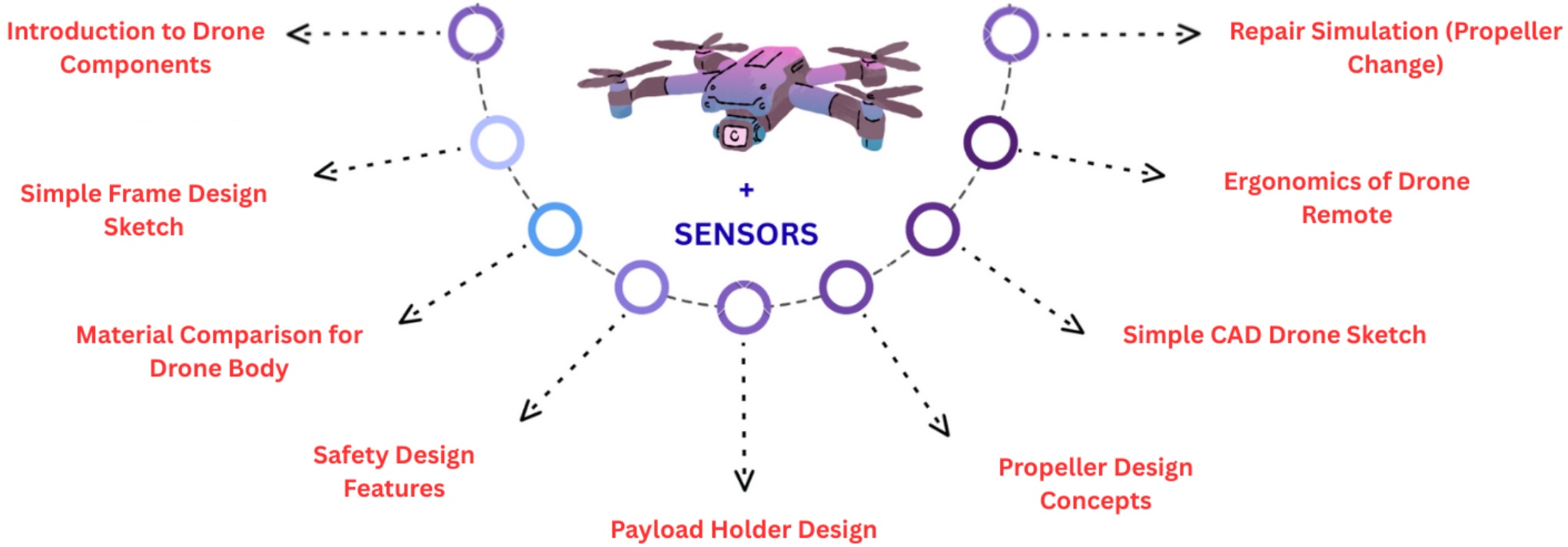


Computer Science

Activity Name	Detailed Description	Curriculum Link	Time Required
Drone Programming Basics	Students write a simple code to take off, hover, and land. Learn about command sequencing.	**Computational Thinking – Algorithms & control structures. Criterion A: Knowing & Understanding**	~1.5 hrs (20 min intro, 40 min coding, 30 min testing)
Autonomous Path Planning	Program drone to follow a square or triangle path. Students refine code to correct errors.	**Programming – Loops & iteration. Criterion B: Inquiring & Designing**	~2 hrs (30 min coding, 1 hr testing, 30 min debugging)
AI Object Tracking	Use drone vision/AI to follow a moving object. Students interpret bounding boxes in live feed.	**Data & AI – Machine learning basics, image recognition. Criterion C: Processing & Evaluating**	~2 hrs (20 min setup, 1 hr trials, 40 min reflection)
Sensor Data Logging	Drone collects barometer, gyroscope, GPS data during flight. Students export to CSV.	**Data Handling – Collecting & analyzing structured data. Criterion A: Knowing & Understanding**	~1.5 hrs (20 min setup, 40 min flight, 30 min analysis)
Obstacle Avoidance Coding	Students write algorithm for drone to detect obstacle and reroute using if-else conditions.	**Programming – Conditional logic. Criterion B: Inquiring & Designing**	~2 hrs (30 min coding, 1 hr testing, 30 min refinement)
Delivery Simulation	Students simulate package drop using drone + servo. Code triggers release at correct GPS point.	**Systems – Embedded systems & automation. Criterion D: Applying CS in real-life contexts**	~2.5 hrs (30 min setup, 1 hr coding, 1 hr testing)

Flight Data Visualization	Students plot drone telemetry (altitude vs time, battery vs time) using Python/Excel.	**Data Science – Visualization of datasets. Criterion C: Processing & Evaluating**	~1.5 hrs (20 min setup, 40 min data, 30 min graphing)
Encryption in Drone Signals	Students learn basics of securing drone communication. Compare unencrypted vs encrypted commands.	**Networks & Security – Encryption basics. Criterion A: Knowing & Understanding**	~2 hrs (30 min intro, 1 hr activity, 30 min reflection)
Swarm Programming	Students simulate 2–3 drones flying in formation using synchronized commands.	**Distributed Systems – Parallel algorithms & synchronization. Criterion B: Inquiring & Designing**	~2 hrs (30 min coding, 1 hr trials, 30 min reflection)

GRADE 9: DESIGN TECHNOLOGY

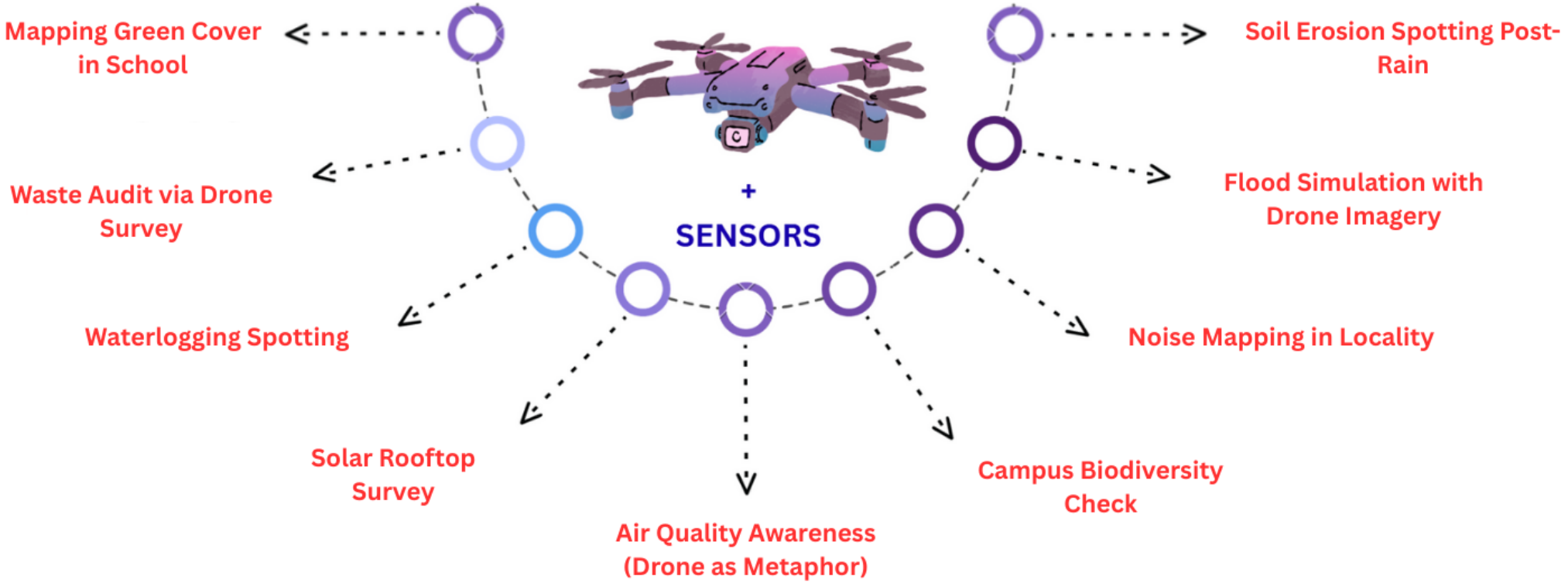


Design Technology

Activity Name	Detailed Description	Curriculum Link	Time Required
Drone Frame Design	Students sketch and model lightweight drone frames on paper or CAD. Compare strength vs weight.	**Criterion A: Inquiring & Analyzing – Material properties and design needs**	~2 hrs (30 min research, 1 hr design, 30 min review)
Propeller Efficiency Test	Swap propellers of different shapes/materials. Measure thrust and noise.	**Criterion C: Creating the Solution – Testing materials & design iteration**	~2 hrs (20 min setup, 1 hr testing, 40 min analysis)
3D Printing a Drone Part	Students CAD model a landing gear or mount, then 3D print.	**Criterion B: Developing Ideas – Using digital tools (CAD)**	~3 hrs (1 hr CAD, 1 hr printing, 1 hr assembly)
Drone Payload Holder	Design and build a small carrier to attach under drone for package drops.	**Criterion C: Creating the Solution – Prototyping and testing designs**	~2.5 hrs (30 min design, 1 hr build, 1 hr test)
Wind Tunnel Test	Use fan to create airflow, test stability of different drone frame shapes.	**Criterion A: Inquiring & Analyzing – Aerodynamic performance**	~2 hrs (30 min setup, 1 hr testing, 30 min reflection)
Sustainable Drone Materials	Research bamboo, recycled plastics, composites for drone construction. Students present pros/cons.	**Criterion D: Evaluating – Sustainability in product design**	~1.5 hrs (30 min research, 30 min analysis, 30 min presentation)
User-Centered Controller Design	Students redesign remote controller layout for ease of use. Create sketches and mock-ups.	**Criterion B: Developing Ideas – Ergonomics and user interface design**	~2 hrs (30 min intro, 1 hr design, 30 min feedback)
Drone Assembly Lab	Students disassemble & reassemble a small drone. Identify components (motors, ESC, sensors).	**Criterion A: Inquiring & Analyzing – Understanding systems & subsystems**	~2 hrs (30 min demo, 1 hr activity, 30 min discussion)

Prototype Testing & Iteration	Students test their custom frame or payload design. Collect performance data, redesign.	**Criterion C: Creating the Solution – Iterative design cycle**	~3 hrs (1 hr building, 1 hr testing, 1 hr redesign)

GRADE 9: ENVIRONMENT SCIENCE & SOCIETY



Environment Systems and Societies

Activity Name	Detailed Description	Curriculum Link	Time Required
Air Quality Mapping	Attach air quality sensor (PM2.5/CO_2) to drone. Fly around campus and record pollution hotspots.	**Topic: Atmospheric Systems – Human impacts on air quality. Criterion A: Knowing & Understanding**	~2.5 hrs (30 min setup, 1 hr flight, 1 hr analysis)
Heat Island Effect Study	Use drone with infrared/thermal sensor to map ground temperature across shaded vs concrete areas.	**Topic: Ecosystems – Microclimates & urbanization effects. Criterion B: Inquiring & Designing**	~2 hrs (20 min setup, 1 hr flight, 40 min reflection)
Water Body Monitoring	Drone takes aerial images of nearby pond/river. Students assess algae blooms, turbidity.	**Topic: Aquatic Systems – Freshwater quality & eutrophication. Criterion C: Processing & Evaluating**	~2 hrs (30 min prep, 1 hr flights, 30 min report)
Deforestation Aerial Survey	Drone photographs tree cover in a patch. Students calculate canopy cover % using image analysis.	**Topic: Terrestrial Systems – Land use & deforestation. Criterion D: Evaluating**	~2.5 hrs (30 min setup, 1 hr flights, 1 hr data processing)
Biodiversity Count	Use drone camera to observe birds/animals in school green zone. Students tally sightings.	**Topic: Biodiversity & Conservation – Species diversity indices. Criterion A: Knowing & Understanding**	~2 hrs (30 min setup, 1 hr observation, 30 min calculations)
Soil Erosion Mapping	Capture aerial images of sloped ground after rain. Students identify erosion patterns.	**Topic: Soil Systems – Erosion & conservation. Criterion B: Inquiring & Designing**	~2 hrs (30 min setup, 1 hr flights, 30 min analysis)
Renewable Energy Study	Students design drone survey of school roof to identify best solar panel installation sites.	**Topic: Energy Systems – Renewable vs non-renewable energy. Criterion D: Evaluating**	~2 hrs (30 min planning, 1 hr drone survey, 30 min report)

Flood Risk Simulation	Drone maps terrain elevation near water drain areas. Students create flood risk maps.	**Topic: Natural Hazards – Flooding & land-use planning. Criterion C: Processing & Evaluating**	~2.5 hrs (30 min setup, 1 hr flights, 1 hr mapping)
Noise Pollution Study	Use drone microphones to map noise levels near busy vs quiet areas on campus.	**Topic: Pollution – Noise as an environmental stressor. Criterion B: Inquiring & Designing**	~2 hrs (20 min setup, 1 hr data collection, 40 min analysis)

MYP Year 5

GRADE 10: PHYSICS

+

SENSORS

Projectile Motion Drop Study

Centripetal Force with Circular Flight

Drone Lift vs Thrust Measurement

Pressure vs Altitude Data

Doppler Effect with Drone Noise

Energy Efficiency of Propeller Designs

Uniform Acceleration Experiment

Wave Interference with Sound Recordings

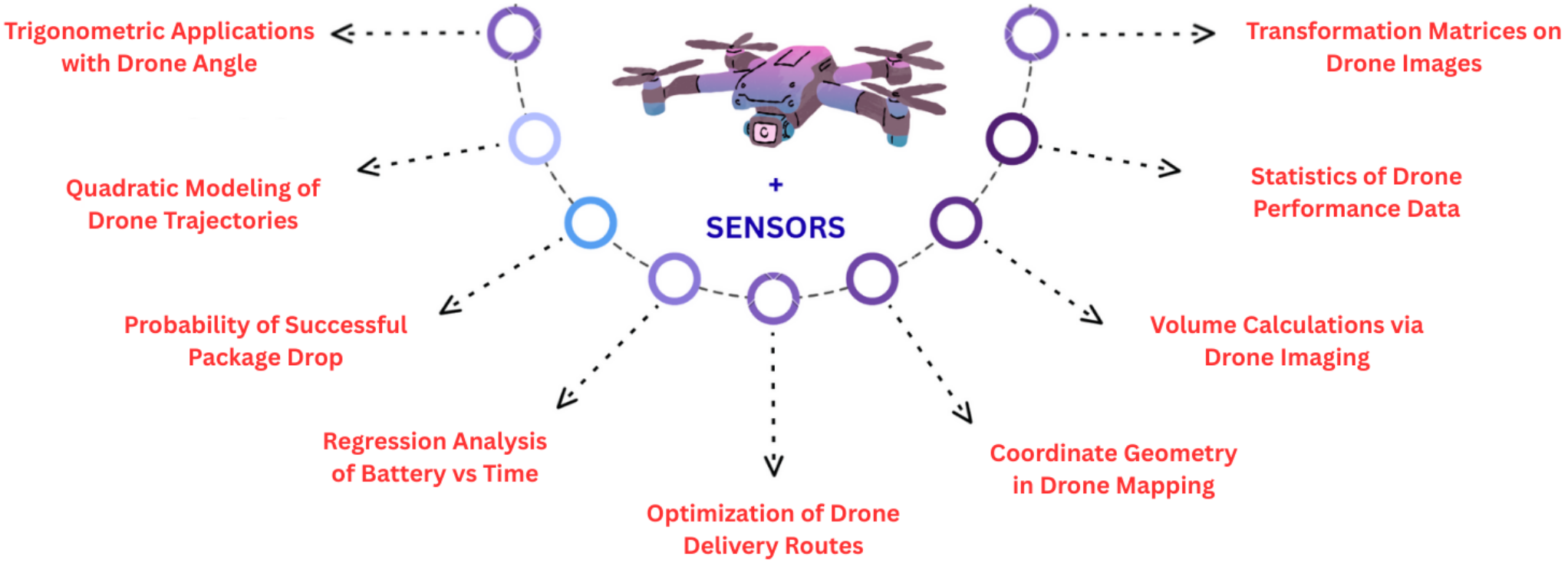
Work-Energy Calculations in Payload Lifting

Physics

Activity Name	Detailed Description	Curriculum Link	Time Required
Projectile Motion Analysis	Launch lightweight payload from drone at different angles. Compare measured vs theoretical range/time.	**Mechanics – Projectile motion, 2D vectors. Criterion C: Processing & Evaluating**	~2.5 hrs (30 min setup, 1 hr flights, 1 hr analysis)
Drone Thrust vs Weight	Measure maximum payload a drone can lift. Plot thrust vs weight curve.	**Forces – Newton's 2nd Law (F = ma), weight & lift. Criterion A: Knowing & Understanding**	~2 hrs (20 min setup, 1 hr trials, 40 min calculations)
Energy Transfer Efficiency	Compare drone's electrical energy input (battery drain) with mechanical work done (payload × height).	**Energy – Efficiency, energy transfer calculations. Criterion C: Processing & Evaluating**	~2 hrs (30 min setup, 1 hr data, 30 min analysis)
Wind Resistance Test	Fly drone in outdoor wind vs indoor still air. Record drift and energy consumption.	**Forces – Air resistance & drag. Criterion B: Inquiring & Designing**	~2 hrs (20 min setup, 1 hr flights, 40 min reflection)
Electromagnetic Interference	Place drone near power lines/electronics. Record GPS signal quality & stability.	**Waves & EM – Interference with signals. Criterion D: Evaluating**	~2 hrs (30 min setup, 1 hr trials, 30 min analysis)
Sound Spectrum Analysis	Record drone sound with spectrum analyzer app. Identify dominant frequencies & harmonics.	**Waves – Frequency analysis & Fourier decomposition. Criterion A: Knowing & Understanding**	~1.5 hrs (20 min setup, 40 min data, 30 min analysis)
Circular Motion Validation	Program drone in uniform circular path. Calculate centripetal acceleration from velocity & radius.	**Mechanics – Circular motion & centripetal force. Criterion C: Processing & Evaluating**	~2 hrs (20 min setup, 1 hr data, 40 min analysis)

Thermal Impact Study	Measure battery & motor temperatures before/after extended flights.	**Thermodynamics – Heat transfer, efficiency limits. Criterion B: Inquiring & Designing**	~2 hrs (20 min setup, 1 hr flights, 40 min reporting)
Resonance & Vibrations	Attach lightweight beam to drone. Identify vibration patterns at different RPMs.	**Waves – Resonance & natural frequency. Criterion D: Evaluating**	~2 hrs (30 min setup, 1 hr tests, 30 min analysis)

GRADE 10: MATHEMATICS

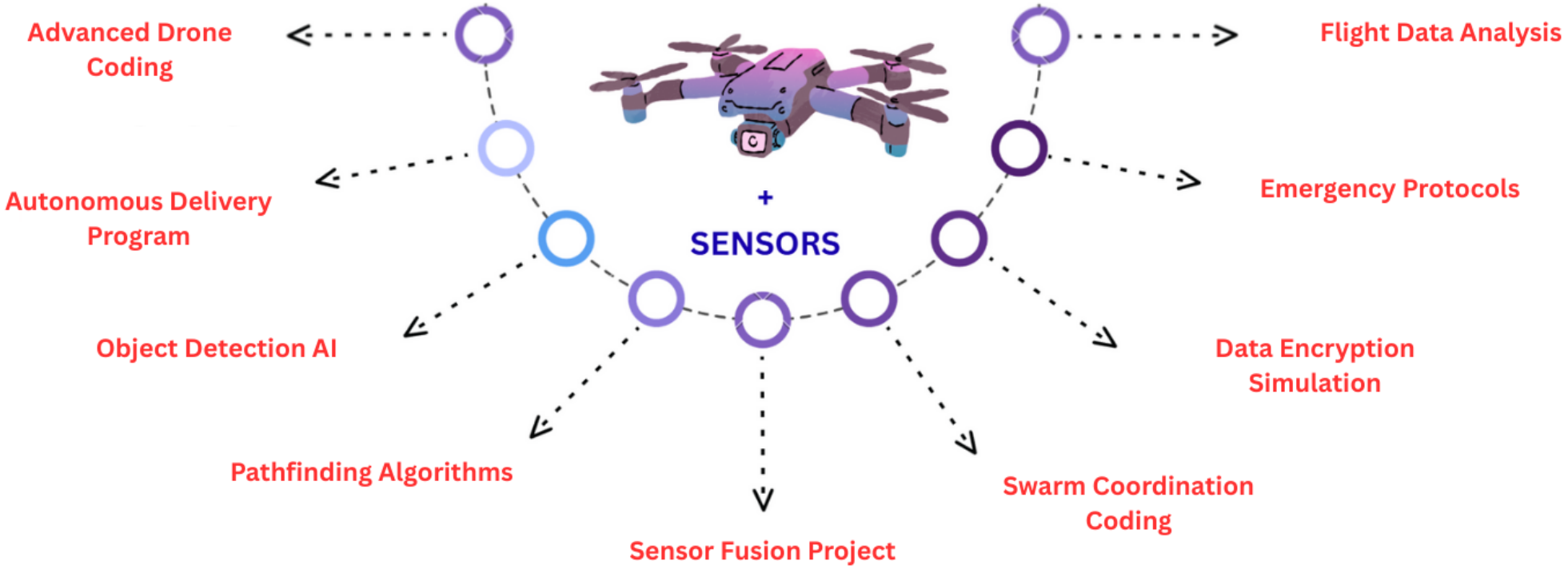


Mathematics

Activity Name	Detailed Description	Curriculum Link	Time Required
Quadratic Trajectories	Program drone to launch payload at different angles. Record height vs time and fit quadratic equations.	**Algebra – Quadratic modeling of motion. Criterion C: Communicating**	~2.5 hrs (30 min setup, 1 hr trials, 1 hr graphing)
Trigonometry in Surveying	Use drone altitude and measured angles of elevation to calculate distances to buildings/objects.	**Geometry – Trigonometry in real-world contexts. Criterion A: Knowing & Understanding**	~2 hrs (20 min setup, 1 hr trials, 40 min calculations)
Exponential Battery Decay	Record drone battery discharge at fixed intervals. Fit exponential decay model & calculate rate constant.	**Functions – Exponential functions in modeling. Criterion C: Communicating**	~2 hrs (20 min setup, 1 hr flights, 40 min modeling)
Probability of Target Landings	Conduct 50 landings on marked pad. Compute probability distribution of accuracy zones.	**Statistics – Probability distributions (binomial/empirical). Criterion B: Inquiring & Designing**	~2 hrs (30 min setup, 1 hr flights, 30 min analysis)
Regression Analysis	Collect flight altitude vs battery usage. Apply linear & non-linear regression. Compare accuracy.	**Statistics – Regression & correlation. Criterion C: Communicating**	~2.5 hrs (30 min setup, 1 hr flights, 1 hr analysis)
Optimization of Flight Routes	Model drone delivery paths between multiple waypoints. Use graph theory/shortest path algorithm.	**Discrete Math – Graph theory & optimization. Criterion D: Applying mathematics in real-life contexts**	~2.5 hrs (30 min intro, 1 hr modeling, 1 hr solution)
Coordinate Geometry Mapping	Plot drone GPS coordinates on Cartesian plane. Calculate slopes & midpoints between waypoints.	**Geometry – Coordinate geometry (slopes, midpoints). Criterion A: Knowing & Understanding**	~2 hrs (20 min setup, 1 hr mapping, 40 min calculations)

Transformation of Paths	Program drone to fly polygons. Analyze transformations (rotations, reflections, enlargements) of paths.	**Geometry – Transformations in plane geometry. Criterion B: Inquiring & Designing**	~2 hrs (30 min setup, 1 hr flights, 30 min analysis)
Mensuration with Drone Imaging	Use aerial image of irregular plot. Approximate area using trapezoidal/Simpson's rule.	**Geometry – Mensuration & numerical integration. Criterion D: Applying mathematics in real-life contexts**	~2 hrs (20 min setup, 1 hr image analysis, 40 min calculations)

GRADE 10: COMPUTER SCIENCE

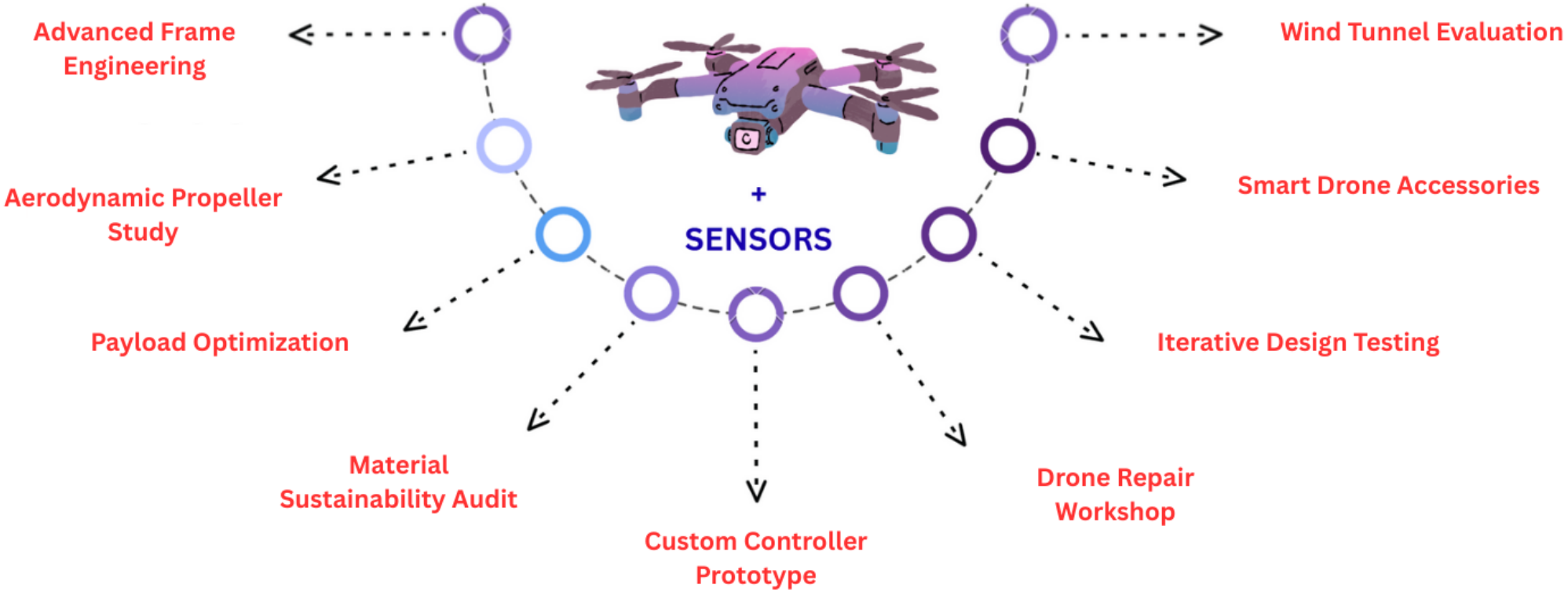


Computer Science

Activity Name	Detailed Description	Curriculum Link	Time Required
Advanced Drone Coding	Students write Python/Blockly scripts for precise maneuvers (square, figure-8). Debug errors.	**Programming – Algorithm design, debugging. Criterion B: Inquiring & Designing**	~2 hrs (30 min coding, 1 hr testing, 30 min reflection)
Autonomous Delivery Program	Code drone to navigate to set GPS points and drop a payload automatically.	**Systems – Automation & real-world applications. Criterion D: Applying CS in real-life contexts**	~2.5 hrs (30 min coding, 1.5 hrs testing, 30 min reflection)
Object Detection AI	Use pre-trained AI model to detect obstacles/people in camera feed. Students test accuracy.	**Data Science – Machine learning models. Criterion A: Knowing & Understanding**	~2 hrs (20 min setup, 1 hr testing, 40 min evaluation)
Pathfinding Algorithms	Students implement A* or Dijkstra algorithm for optimal drone path planning.	**Algorithms – Search & optimization. Criterion C: Processing & Evaluating**	~2.5 hrs (30 min intro, 1.5 hrs coding, 30 min testing)
Sensor Fusion Project	Combine accelerometer + GPS + barometer data to improve positioning accuracy.	**Data Handling – Integration of multiple data sources. Criterion C: Processing & Evaluating**	~2 hrs (20 min setup, 1 hr data, 40 min analysis)
Swarm Coordination Coding	Students code two drones to fly in formation using synchronized loops/conditions.	**Distributed Systems – Parallelism & synchronization. Criterion B: Inquiring & Designing**	~2 hrs (30 min coding, 1 hr flight, 30 min reflection)
Data Encryption Simulation	Students test encrypted vs unencrypted communication for drone command signals.	**Networks & Security – Encryption basics, data integrity. Criterion A: Knowing & Understanding**	~1.5 hrs (20 min intro, 40 min coding, 30 min discussion)

Emergency Protocols	Students design pseudocode for emergency actions (GPS lost, low battery, obstacle detected).	**Problem Solving – Flowcharts, exception handling. Criterion D: Applying CS in real-life contexts**	~1.5 hrs (30 min design, 40 min coding, 20 min reflection)
Flight Data Analysis	Export drone telemetry, use Python/Excel to calculate speed, acceleration, energy use.	**Data Science – Big data handling & visualization. Criterion C: Processing & Evaluating**	~2 hrs (20 min export, 1 hr analysis, 40 min report)

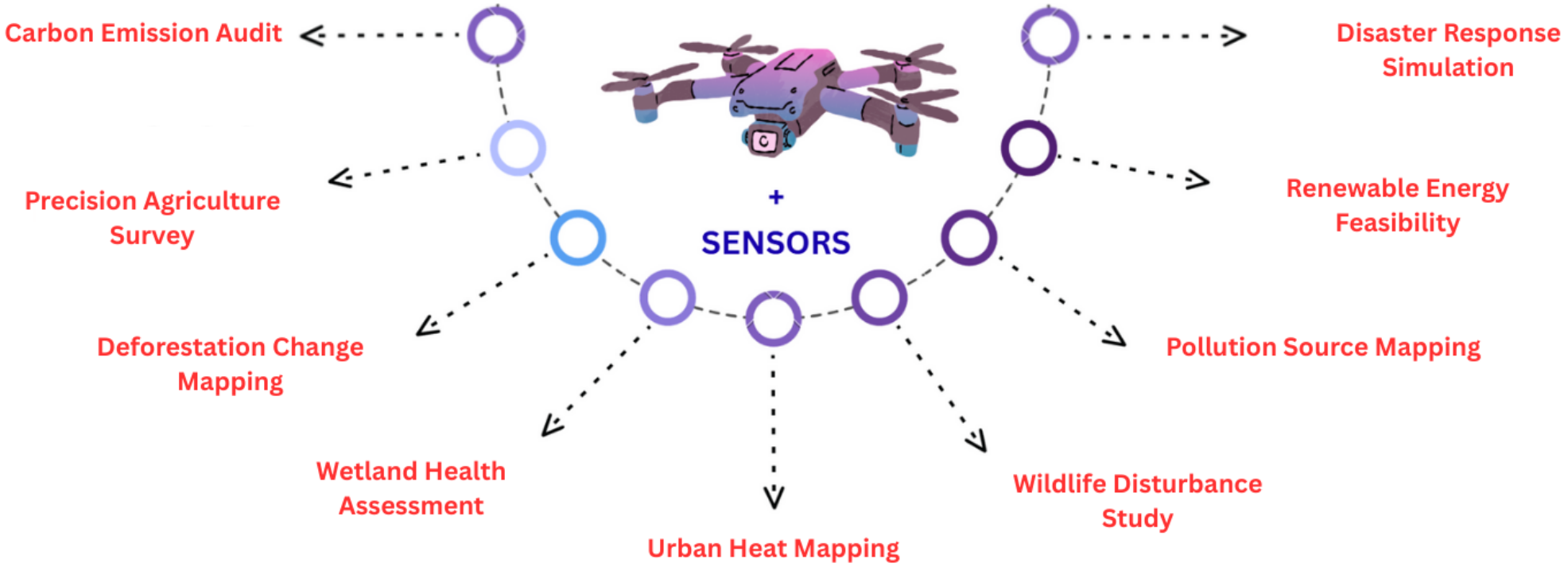
GRADE 10: DESIGN TECHNOLOGY



Design Technology

Activity Name	Detailed Description	Curriculum Link	Time Required
Advanced Frame Engineering	Students redesign drone frames using CAD. Simulate stress/strain before prototyping.	**Criterion A: Inquiring & Analyzing – Materials, stresses, and design optimization**	~3 hrs (1 hr CAD, 1 hr sim, 1 hr review)
Aerodynamic Propeller Study	Design and 3D print propeller variants. Test thrust, lift, and efficiency.	**Criterion C: Creating the Solution – Rapid prototyping and testing**	~3 hrs (1 hr CAD, 1 hr printing, 1 hr testing)
Payload Optimization	Students design modular carriers (food, sensors, medicine). Test efficiency & balance.	**Criterion B: Developing Ideas – Functional design concepts**	~2.5 hrs (30 min design, 1 hr build, 1 hr test)
Material Sustainability Audit	Compare carbon fiber, PLA, aluminum, bamboo for drone part manufacturing.	**Criterion D: Evaluating – Environmental impact & sustainability in design**	~2 hrs (30 min research, 1 hr analysis, 30 min presentation)
Custom Controller Prototype	Build ergonomic remote/controller prototype (foam/cardboard/CAD). Test usability.	**Criterion B: Developing Ideas – Human-centered design**	~2.5 hrs (30 min design, 1 hr build, 1 hr testing)
Drone Repair Workshop	Students diagnose and repair basic faults (motor replacement, propeller balancing).	**Criterion A: Inquiring & Analyzing – System components & troubleshooting**	~2 hrs (30 min demo, 1 hr repair, 30 min reflection)
Iterative Design Testing	Test multiple versions of student-created drone parts. Compare results and iterate.	**Criterion C: Creating the Solution – Iterative prototyping**	~3 hrs (1 hr build, 1 hr test, 1 hr redesign)
Smart Drone Accessories	Students design add-ons (camera gimbal, safety cage, parachute system).	**Criterion B: Developing Ideas – Innovation & functional add-ons**	~2.5 hrs (30 min design, 1 hr build, 1 hr test)
Wind Tunnel Evaluation	Test aerodynamic efficiency of student-designed frames in a small fan tunnel.	**Criterion A: Inquiring & Analyzing – Aerodynamics in engineering design**	~2 hrs (30 min setup, 1 hr testing, 30 min reflection)

GRADE 10: ENVIRONMENT SCIENCE & SOCIETY

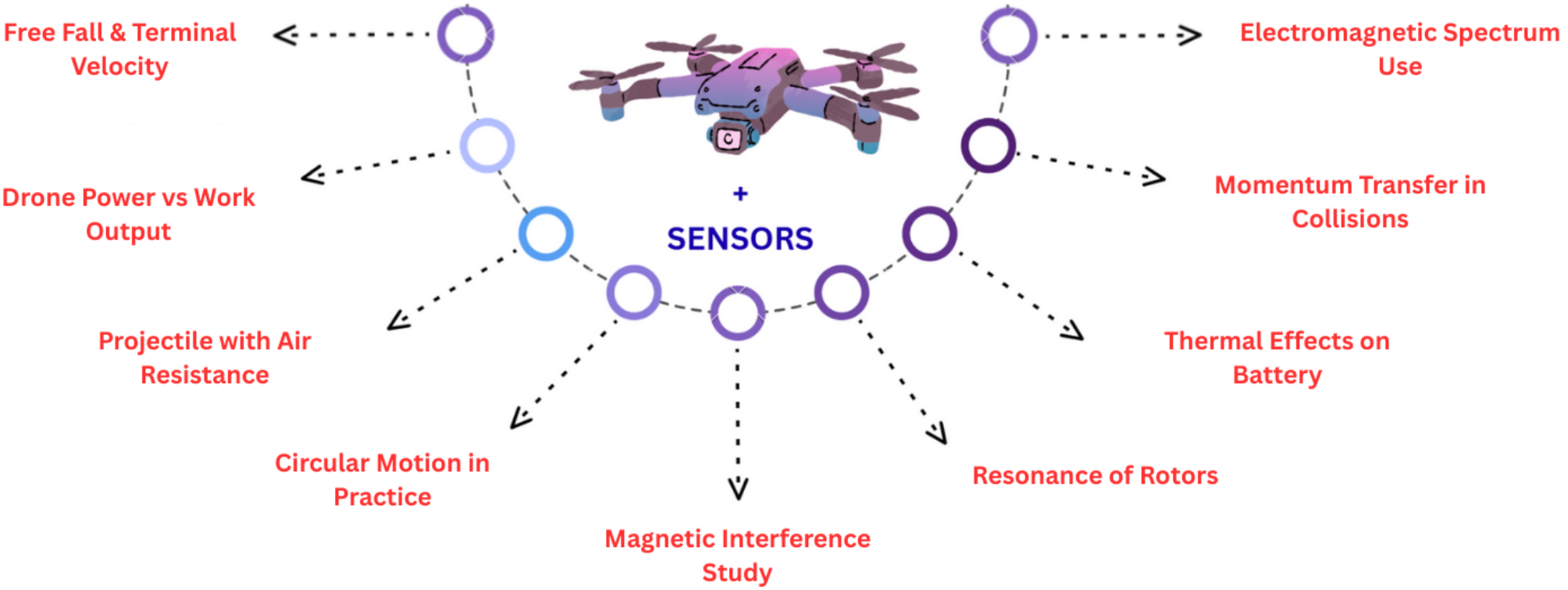


Environmental Systems and Societies

Activity Name	Detailed Description	Curriculum Link	Time Required
Carbon Emission Audit	Students calculate lifecycle CO_2 footprint of drone use vs trucks for last-mile delivery.	**Topic: Sustainability – Carbon cycles, human impact. Criterion D: Evaluating**	~2 hrs (30 min research, 1 hr calc, 30 min reflection)
Precision Agriculture Survey	Use drones to capture NDVI images of crops (mock or real). Interpret plant health indices.	**Topic: Ecosystems – Agricultural systems & monitoring. Criterion B: Inquiring & Designing**	~2.5 hrs (30 min setup, 1 hr flight, 1 hr analysis)
Deforestation Change Mapping	Compare aerial images of same site over time (schoolyard/nearby land). Calculate canopy % change.	**Topic: Terrestrial Systems – Deforestation & land use. Criterion C: Processing & Evaluating**	~2 hrs (20 min image capture, 1 hr analysis, 40 min reflection)
Wetland Health Assessment	Drone surveys pond edges, students map water levels & vegetation zones.	**Topic: Aquatic Systems – Freshwater wetlands. Criterion A: Knowing & Understanding**	~2 hrs (30 min setup, 1 hr survey, 30 min discussion)
Urban Heat Mapping	Drone thermal camera surveys asphalt vs grass areas. Students interpret heat island effect.	**Topic: Atmosphere – Urban climate change impacts. Criterion C: Processing & Evaluating**	~2 hrs (20 min setup, 1 hr survey, 40 min reporting)
Wildlife Disturbance Study	Observe and record local birds/animals responding to drone flights. Discuss ethical concerns.	**Topic: Biodiversity – Human interaction with species. Criterion D: Evaluating**	~1.5 hrs (20 min setup, 40 min observation, 30 min reflection)
Pollution Source Mapping	Drone captures aerial photos of campus drains/waste areas. Students map waste hotspots.	**Topic: Pollution – Solid waste management. Criterion B: Inquiring & Designing**	~2 hrs (30 min setup, 1 hr survey, 30 min report)

Renewable Energy Feasibility	Drone surveys rooftops for solar panel placement. Students calculate potential energy generation.	**Topic: Energy Systems – Renewable energy. Criterion C: Processing & Evaluating**	~2.5 hrs (30 min setup, 1 hr data, 1 hr calculation)
Disaster Response Simulation	Drone used for mock flood or earthquake site mapping. Students propose emergency uses.	**Topic: Natural Hazards – Disaster management. Criterion A: Knowing & Understanding**	~2 hrs (30 min intro, 1 hr flights, 30 min reflection)

GRADE 11: PHYSICS

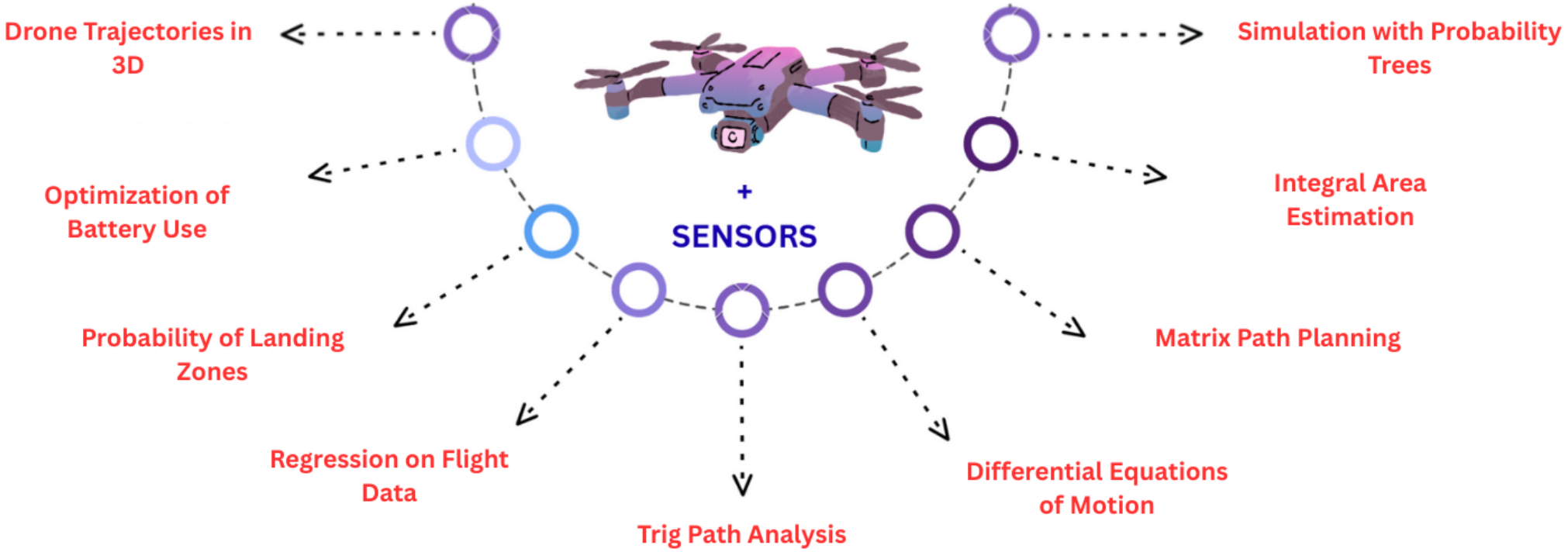


Physics

Activity Name	Detailed Description	Curriculum Link	Time Required
Free Fall & Terminal Velocity	Drop payloads of different masses from a hovering drone. Compare actual vs theoretical terminal velocities.	**Topic 2: Mechanics – Forces of air resistance, terminal velocity**	~2.5 hrs (30 min setup, 1 hr trials, 1 hr analysis)
Drone Power vs Work Output	Measure electrical input (battery drain) vs mechanical work (payload × height).	**Topic 2: Mechanics – Work, energy, power**	~2 hrs (20 min setup, 1 hr trials, 40 min analysis)
Projectile with Air Resistance	Launch small payloads from drone. Compare ideal projectile motion with drag-influenced trajectories.	**Topic 2: Mechanics – Projectile motion & drag**	~2.5 hrs (30 min setup, 1 hr trials, 1 hr modeling)
Circular Motion in Practice	Program drone to fly in horizontal circle. Calculate centripetal acceleration & compare to theory.	**Topic 6: Circular motion & gravitation – Centripetal force**	~2 hrs (20 min setup, 1 hr flight, 40 min calculations)
Magnetic Interference Study	Test drone GPS/compass stability near strong magnets or power lines.	**Topic 5: Electricity & magnetism – Magnetic fields & induced effects**	~2 hrs (30 min setup, 1 hr trials, 30 min analysis)
Resonance of Rotors	Use frequency analyzer app to detect resonance peaks of propeller vibrations.	**Topic 4: Waves – Standing waves, resonance**	~2 hrs (20 min setup, 1 hr data collection, 40 min analysis)
Thermal Effects on Battery	Compare drone performance with batteries pre-cooled vs warmed.	**Topic 3: Thermal physics – Heat transfer & energy efficiency**	~2 hrs (30 min prep, 1 hr flights, 30 min reflection)

Momentum Transfer in Collisions	Drone collides gently with rolling cart. Students analyze momentum conservation.	**Topic 2: Mechanics – Conservation of momentum**	~2 hrs (30 min setup, 1 hr trials, 30 min calculations)
Electromagnetic Spectrum Use	Explore how drones use radio frequencies (2.4/5 GHz). Discuss bandwidth & interference.	**Topic 4: Waves – EM spectrum & communication technologies**	~1.5 hrs (20 min intro, 40 min activity, 30 min discussion)

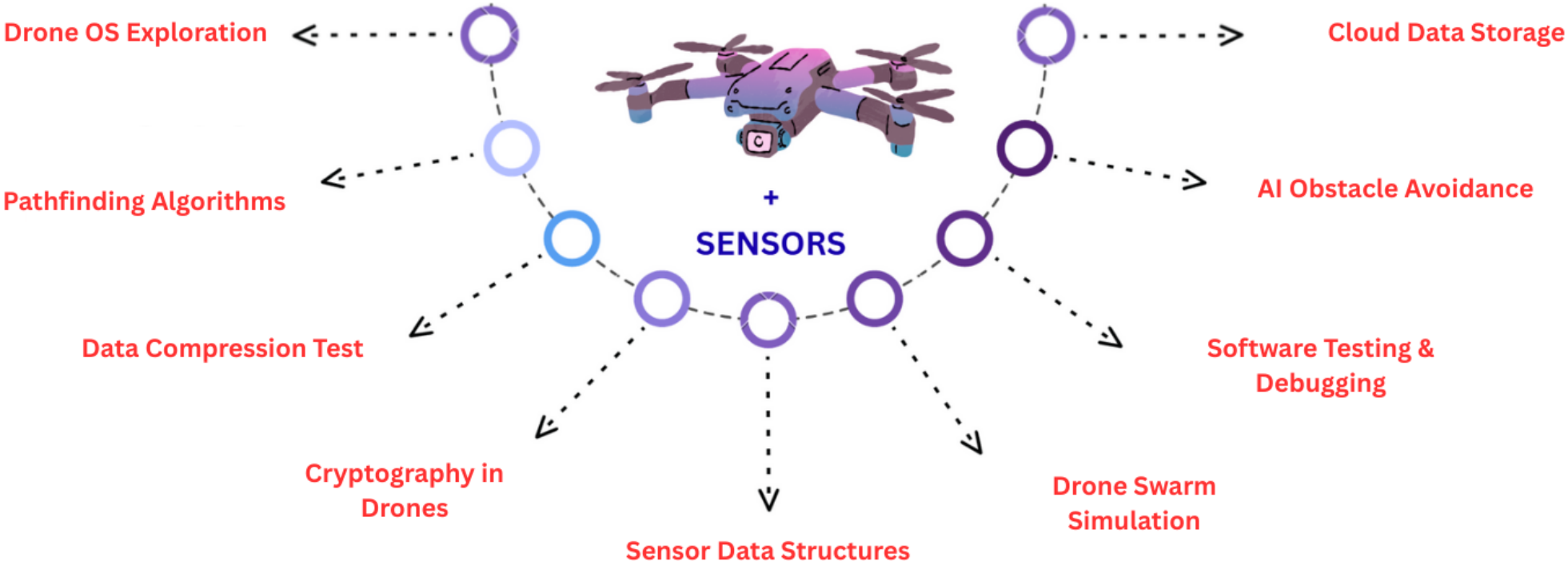
GRADE 11: MATHEMATICS



Mathematics

Activity Name	Detailed Description	Curriculum Link	Time Required
Drone Trajectories in 3D	Model drone motion in 3D using vector equations.	Topic: Vectors – 3D vector equations of motion	~2 hrs
Optimization of Battery Use	Create optimization model for maximizing flight time under constraints.	Topic: Calculus – Optimization problems	~2.5 hrs
Probability of Landing Zones	Simulate drone landings, calculate probability density for accuracy.	Topic: Probability – Normal distribution	~2 hrs
Regression on Flight Data	Collect altitude vs time and apply polynomial regression.	Topic: Statistics – Regression models	~2 hrs
Trig Path Analysis	Model sinusoidal drone paths (hover oscillations).	Topic: Trigonometry – Sinusoidal modeling	~2 hrs
Differential Equations of Motion	Solve ODEs for drone velocity under drag.	Topic: Calculus – First-order DEs in physics	~2.5 hrs
Matrix Path Planning	Use adjacency matrices for drone route optimization.	Topic: Linear Algebra – Matrices in graph theory	~2 hrs
Integral Area Estimation	Use aerial images to approximate land area with integration methods.	Topic: Calculus – Area under curves	~2 hrs
Simulation with Probability Trees	Model probability of drone delivery success across weather conditions.	Topic: Probability – Trees & conditional probability	~1.5 hrs

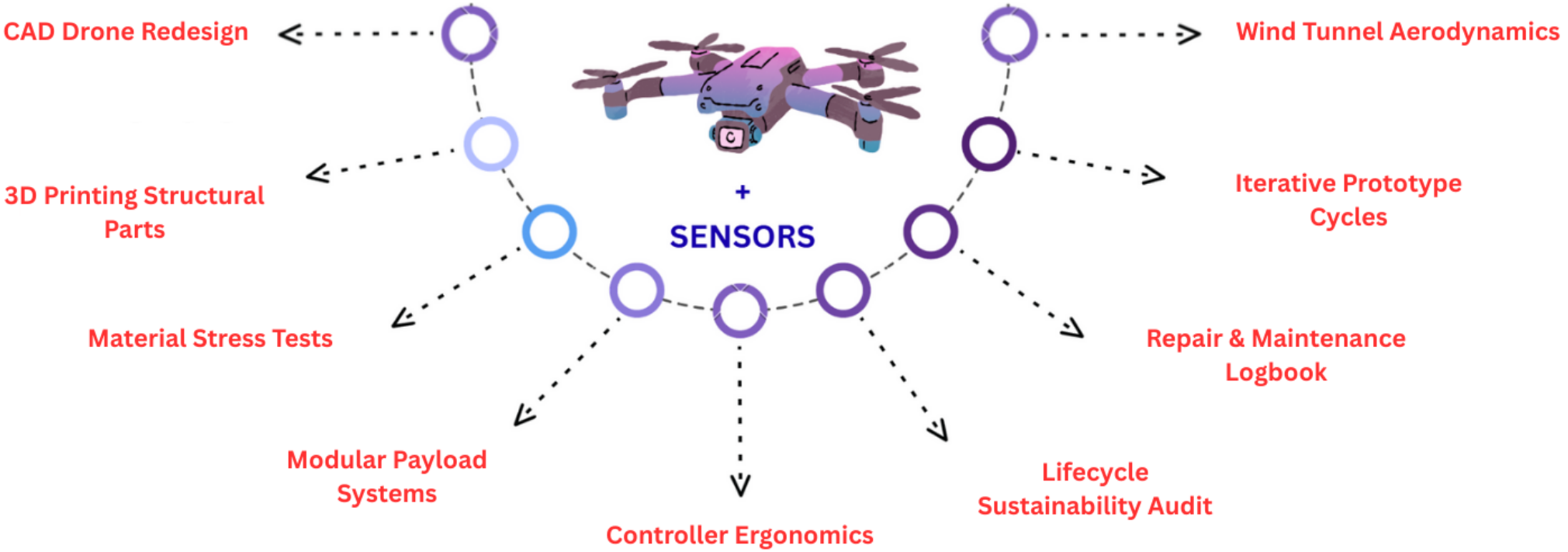
GRADE 11: COMPUTER SCIENCE



Computer Science

Activity Name	Detailed Description	Curriculum Link	Time Required
Drone OS Exploration	Study firmware & OS of drone hardware.	Topic: System fundamentals – OS & embedded systems	~2 hrs
Pathfinding Algorithms	Implement A* algorithm for autonomous navigation.	Topic: Algorithm design – Graph search	~2.5 hrs
Data Compression Test	Compress vs uncompressed video feed, compare efficiency.	Topic: Data representation – Compression	~2 hrs
Cryptography in Drones	Simulate encrypted vs unencrypted commands.	Topic: Security – Encryption methods	~1.5 hrs
Sensor Data Structures	Use arrays/lists to store telemetry (altitude, speed).	Topic: Abstract Data Structures – Arrays	~2 hrs
Drone Swarm Simulation	Simulate 3 drones flying in sync.	Topic: Object-oriented programming – Classes & objects	~2.5 hrs
Software Testing & Debugging	Write test cases for drone flight code.	Topic: Software development – Testing strategies	~2 hrs
AI Obstacle Avoidance	Implement machine learning for detecting and avoiding obstacles.	Topic: Computational thinking – AI applications	~2.5 hrs
Cloud Data Storage	Send drone flight logs to cloud DB.	Topic: Databases – CRUD operations	~2 hrs

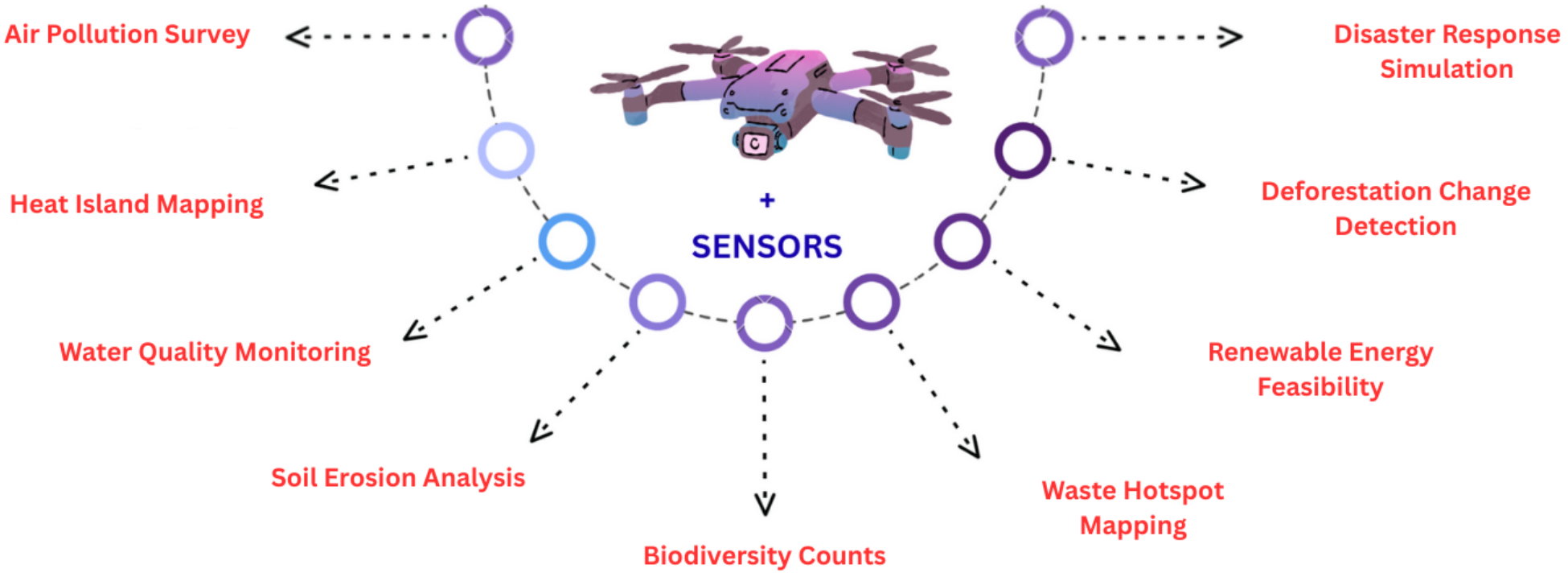
GRADE 11: DESIGN TECHNOLOGY



Design Technology

Activity Name	Detailed Description	Curriculum Link	Time Required
CAD Drone Redesign	Use CAD to redesign arms or frame for strength.	Topic: Human factors & ergonomics – Design analysis	~2.5 hrs
3D Printing Structural Parts	Print landing gear & test durability.	Topic: Innovation & design – Prototyping	~2.5 hrs
Material Stress Tests	Compare carbon fiber, PLA, aluminum under load.	Topic: Materials – Properties testing	~2 hrs
Modular Payload Systems	Design clip-on payload holders.	Topic: Innovation – Modular design	~2 hrs
Controller Ergonomics	Redesign joystick placement for comfort.	Topic: Human factors – Ergonomics	~2 hrs
Lifecycle Sustainability Audit	Assess drone's lifecycle environmental footprint.	Topic: Sustainability – Life cycle analysis	~2 hrs
Repair & Maintenance Logbook	Students maintain log of all repairs.	Topic: Practical design – Maintenance	~1.5 hrs
Iterative Prototype Cycles	Students build, test, redesign drone parts.	Topic: Design cycle – Iterative development	~3 hrs
Wind Tunnel Aerodynamics	Test frame models in airflow.	Topic: Structures – Aerodynamic performance	~2 hrs

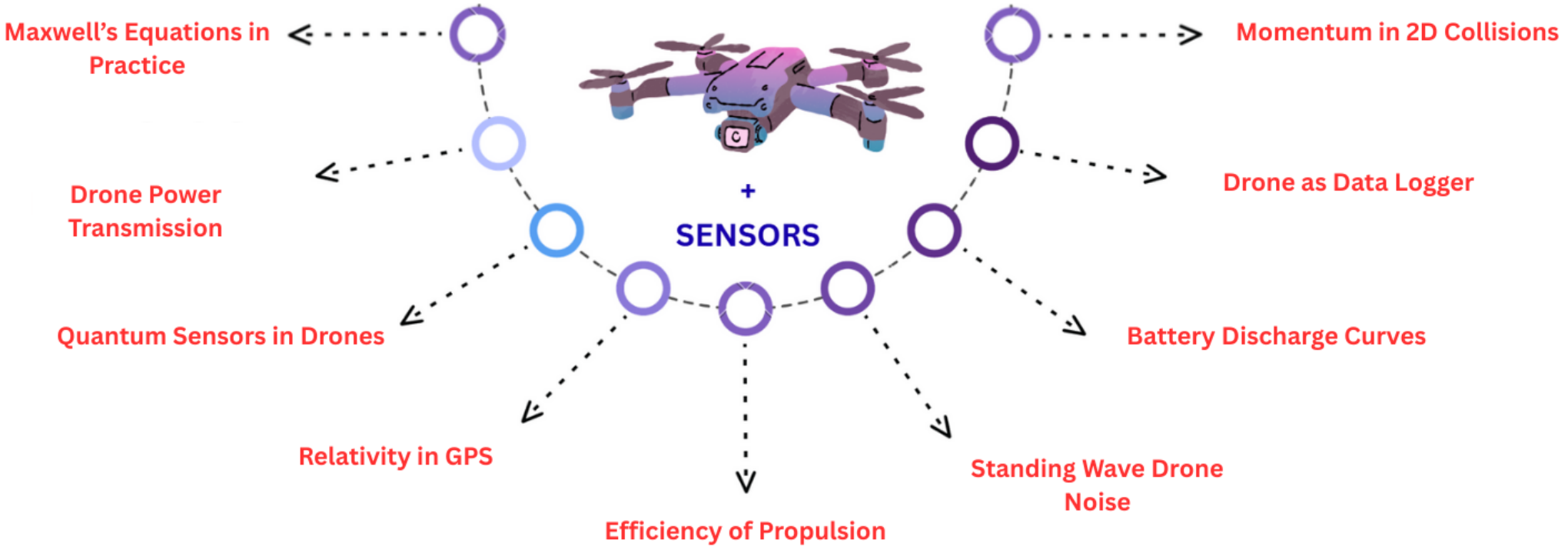
GRADE 11: ENVIRONMENT SCIENCE & SOCIETY



Environmental Systems & Societies

Activity Name	Detailed Description	Curriculum Link	Time Required
Air Pollution Survey	Use drone sensors to monitor air quality over roads.	Topic 6: Atmospheric systems	~2.5 hrs
Heat Island Mapping	Drone infrared survey of campus surfaces.	Topic 7: Climate change & energy production	~2 hrs
Water Quality Monitoring	Capture aerial pond photos for algae bloom analysis.	Topic 5: Aquatic systems	~2 hrs
Soil Erosion Analysis	Post-rain aerial mapping of slopes.	Topic 4: Soil systems	~2 hrs
Biodiversity Counts	Drone imaging of trees for bird/animal counts.	Topic 2: Ecosystems & ecology	~2 hrs
Waste Hotspot Mapping	Aerial survey of campus waste disposal.	Topic 1: Foundations of ESS	~2 hrs
Renewable Energy Feasibility	Drone surveys rooftops for solar placement.	Topic 7: Energy systems	~2.5 hrs
Deforestation Change Detection	Compare aerial canopy coverage over months.	Topic 2: Ecosystem change	~2.5 hrs
Disaster Response Simulation	Drone maps mock flood zones.	Topic 3: Human population & resource use	~2 hrs

GRADE 12: PHYSICS



Physics

Activity Name	Detailed Description	Curriculum Link	Time Required
Maxwell's Equations in Practice	Study drone comm signals using EM spectrum.	Topic 11: Electromagnetism	~2 hrs
Drone Power Transmission	Wireless charging experiment.	Topic 11: Electromagnetic induction	~2 hrs
Quantum Sensors in Drones	Explore theoretical use of quantum gyros.	HL Extension – Quantum & nuclear physics	~2 hrs
Relativity in GPS	Study relativistic corrections in drone GPS.	Topic 10: Fields – Relativity	~2 hrs
Efficiency of Propulsion	Analyze prop efficiency at different RPMs.	Topic 2 & 10: Energy and fields	~2.5 hrs
Standing Wave Drone Noise	Sound wave interference mapping.	Topic 4: Waves – Superposition	~2 hrs
Battery Discharge Curves	Plot I-V characteristics of LiPo batteries.	Topic 5: Electricity	~2 hrs
Drone as Data Logger	Drone used to record motion for IB IA experiment.	Internal Assessment support	~3 hrs
Momentum in 2D Collisions	Drone pushing carts at angles.	Topic 2: Mechanics – 2D momentum	~2 hrs

GRADE 12: MATHEMATICS

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SENSORS

Differential Equations Flight

Optimization (Fuel vs Distance)

Probability & Risk Modeling

Regression (Nonlinear)

Fourier Analysis of Drone Noise

Matrix Transformations

3D Vectors in Navigation

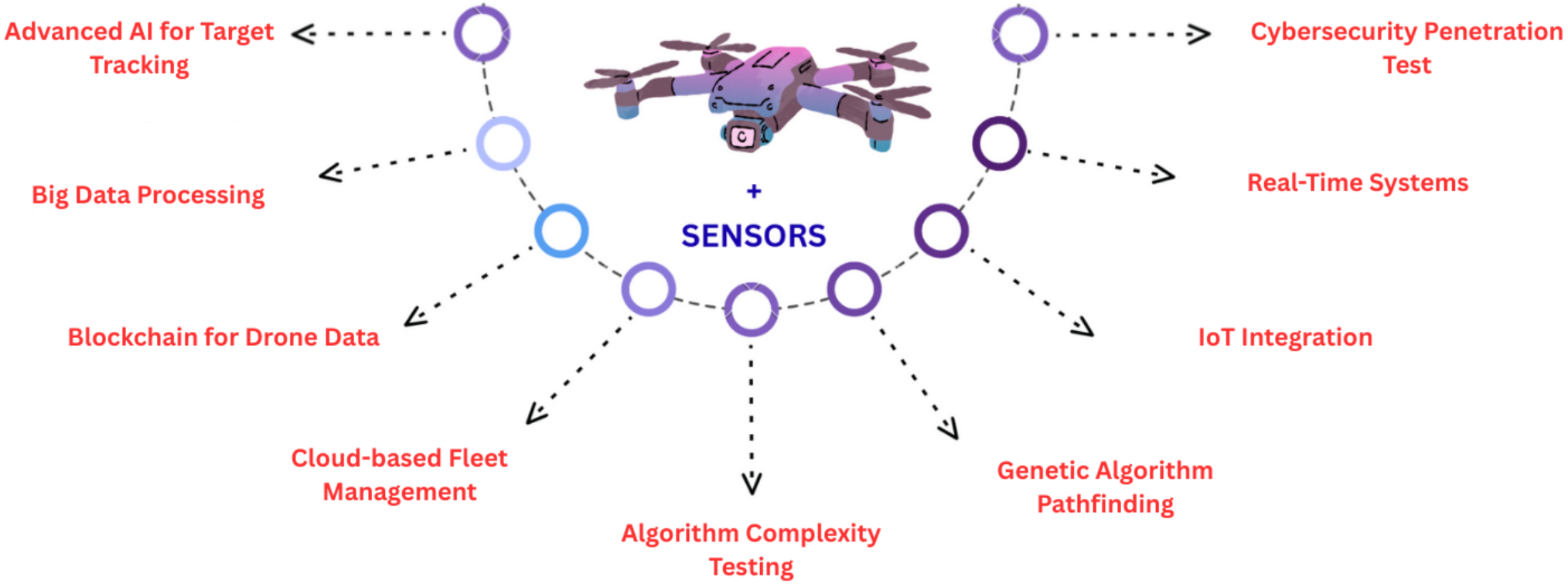
Monte Carlo Simulation

Integration in Mapping

Mathematics

Activity Name	Detailed Description	Curriculum Link	Time Required
Differential Equations Flight	Model drone velocity with 2nd-order DE under drag.	Topic: Calculus – Differential equations	~2.5 hrs
Optimization (Fuel vs Distance)	Multi-variable optimization for efficiency.	Topic: Calculus – Multivariable functions	~2.5 hrs
Probability & Risk Modeling	Model probability of mission failure under weather risk.	Topic: Statistics – Risk analysis	~2 hrs
Regression (Nonlinear)	Fit drone thrust vs speed data to non-linear models.	Topic: Statistics – Nonlinear regression	~2 hrs
Fourier Analysis of Drone Noise	Analyze drone prop sound with Fourier series.	Topic: Calculus – Series & periodic functions	~2.5 hrs
Matrix Transformations	Use matrices to simulate drone flight rotations.	Topic: Linear Algebra – Transformations	~2 hrs
3D Vectors in Navigation	Model multi-step drone flights as 3D vectors.	Topic: Vectors – 3D navigation	~2 hrs
Monte Carlo Simulation	Use Monte Carlo for predicting drone delivery times.	Topic: Probability & Statistics – Simulation	~2.5 hrs
Integration in Mapping	Approximate irregular land areas with numerical integration.	Topic: Calculus – Applications	~2 hrs

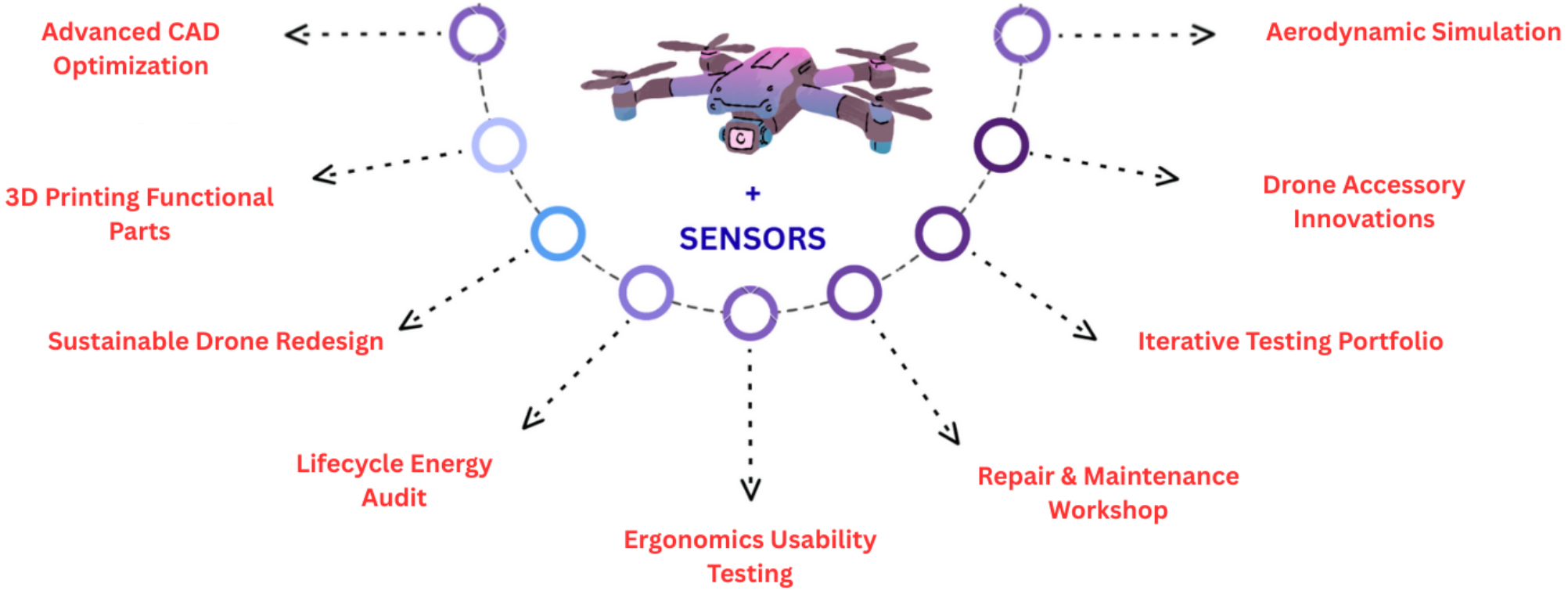
GRADE 12: COMPUTER SCIENCE



Computer Science

Activity Name	Detailed Description	Curriculum Link	Time Required
Advanced AI for Target Tracking	Code AI to follow moving target autonomously.	Option D: OOP & AI	~2.5 hrs
Big Data Processing	Analyze >1,000 telemetry data points.	Topic 6: Resource management	~2 hrs
Blockchain for Drone Data	Simulate blockchain-based drone logging.	Topic 7: Control & security	~2.5 hrs
Cloud-based Fleet Management	Multi-drone cloud command system.	Topic 5: System fundamentals	~2.5 hrs
Algorithm Complexity Testing	Compare pathfinding (A* vs Dijkstra vs BFS).	Topic 4: Algorithm design	~2 hrs
Genetic Algorithm Pathfinding	Use GA to evolve optimal flight paths.	HL Extension – Intelligent systems	~2.5 hrs
IoT Integration	Connect drone data with IoT dashboard.	Topic 2: Computer organization	~2 hrs
Real-Time Systems	Test latency in drone command execution.	Topic 1: System fundamentals	~2 hrs
Cybersecurity Penetration Test	Simulate hacking drone comms.	Topic 7: Security & integrity	~2.5 hrs

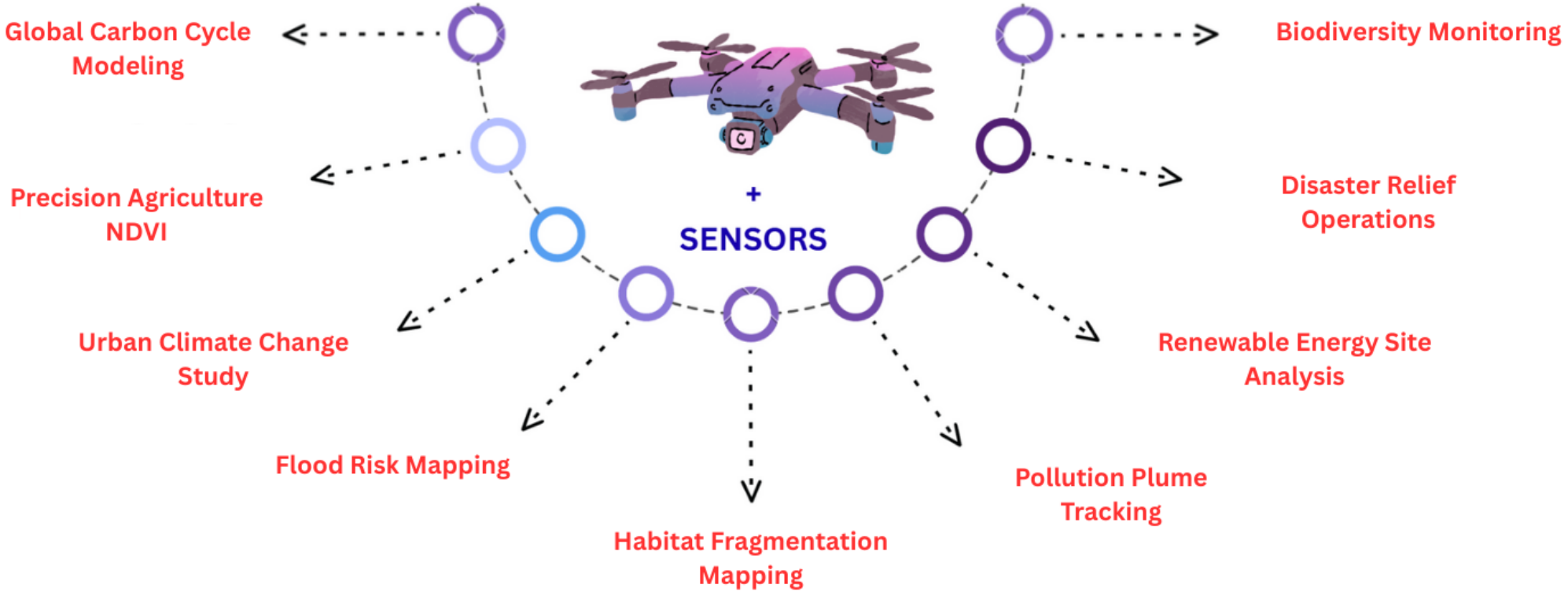
GRADE 12: DESIGN TECHNOLOGY



Design Technology

Activity Name	Detailed Description	Curriculum Link	Time Required
Advanced CAD Optimization	Use FEA to optimize frame for stress.	Topic: Structures – CAD/FEA	~2.5 hrs
3D Printing Functional Parts	Print motor mounts, test in real flights.	Topic: Innovation – Prototyping	~2.5 hrs
Sustainable Drone Redesign	Propose eco-friendly drone model.	Topic: Sustainability – Design thinking	~2 hrs
Lifecycle Energy Audit	Assess entire lifecycle energy footprint.	Topic: Sustainability – Life cycle	~2 hrs
Ergonomics Usability Testing	Test real users with controller redesigns.	Topic: Human factors – Ergonomics	~2 hrs
Repair & Maintenance Workshop	Advanced repair: ESC, motor wiring.	Topic: Practical design – Maintenance	~2.5 hrs
Iterative Testing Portfolio	Document multiple design cycles.	Topic: Design cycle – Reflection	~2 hrs
Drone Accessory Innovations	Design gimbals, parachutes, anti-crash cages.	Topic: Innovation – Product design	~2.5 hrs
Aerodynamic Simulation	Simulate airflow using CFD tools.	Topic: Structures – Aerodynamics	~2.5 hrs

GRADE 12: ENVIRONMENT SCIENCE & SOCIETY



Environment Science and Societies

Activity Name	Detailed Description	Curriculum Link	Time Required
Global Carbon Cycle Modeling	Model emissions from drones vs trucks globally.	Topic 1: Foundations	~2 hrs
Precision Agriculture NDVI	Use drone images to measure crop health indices.	Topic 2: Ecosystems	~2.5 hrs
Urban Climate Change Study	Compare heat islands across multiple zones.	Topic 7: Climate change	~2.5 hrs
Flood Risk Mapping	Drone terrain maps modeled for flood simulation.	Topic 3: Human populations	~2.5 hrs
Habitat Fragmentation Mapping	Drone surveys fragmented habitats.	Topic 2: Ecology	~2.5 hrs
Pollution Plume Tracking	Drone sensors track air pollutant spread.	Topic 6: Atmospheric systems	~2 hrs
Renewable Energy Site Analysis	Rooftop mapping for solar/wind potential.	Topic 7: Energy systems	~2.5 hrs
Disaster Relief Operations	Drones in mock earthquake rescue simulations.	Topic 3: Resource use & disasters	~2 hrs
Biodiversity Monitoring	Long-term canopy & wildlife surveys.	Topic 2: Conservation	~2.5 hrs