

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code & Name : **23EE0302-Electric and Hybrid Vehicles**

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Puzzles / In Class Activities

Topics Covered: **Unit I**

MISSION 1: THE TIME TRAVELER'S PUZZLE - HISTORICAL MILESTONES

Scenario:

You are a time-traveling automotive engineer. Your mission is to restore the correct timeline of HEV/EV development by arranging historical events in chronological order. A villain has scrambled the timeline!

Puzzle: Chronological Sequencing Challenge

Instructions: Arrange these scrambled events in correct historical order from earliest to latest.

Scrambled Events:

1. Tesla Model S becomes best-selling electric car worldwide
2. Toyota Prius launches, starting modern HEV revolution
3. Thomas Parker builds first practical electric car in London
4. GM EV1 production begins (first modern mass-produced EV)
5. Porsche creates Lohner-Porsche hybrid vehicle
6. Oil crises spark renewed EV research
7. Nissan Leaf becomes first mass-market affordable EV
8. General Motors destroys most EV1s, creating controversy

Game Mechanics:

- Drag-and-drop interface
- Time bonus: Complete in <2 minutes for extra points
- Hint system: Can reveal one clue (costs points)
- **Reward:** Unlock "Historian Badge" and access to vintage EV blueprints

MISSION 2: ENVIRONMENTAL IMPACT CALCULATOR PUZZLE

Scenario:

You are an environmental consultant for Chennai city. Calculate the pollution reduction if 10,000 vehicles convert from conventional to hybrid/electric.

Interactive Puzzle: Carbon Footprint Matrix

Given Data:

- Conventional car: 2.5 kg CO₂ per liter petrol, 15 km/liter
- HEV: 40% reduction in fuel consumption
- BEV: 0.95 kg CO₂ per kWh (Tamil Nadu grid), 150 Wh/km
- Daily commute: 30 km per vehicle

Tasks:

1. **Calculation Puzzle:** Fill in the missing values in the table:

Vehicle Type	Daily Fuel/Energy	Daily CO ₂ Emissions	Annual Savings vs. Conventional
Conventional	2 liters	? kg	0 kg
HEV	? liters	3 kg	? kg
BEV	? kWh	? kg	? kg

2. **Logic Puzzle:** If Chennai has 1 million vehicles and targets 30% conversion to HEV/BEV by 2030, what will be the total annual CO₂ reduction?

Game Mechanics:

- Calculator tool provided
- Progressive unlocking: Solve step 1 to unlock step 2
- **Reward:** "Green Engineer Badge" and virtual tree planting in game

MISSION 3: VEHICLE DYNAMICS ESCAPE ROOM

Scenario:

You're trapped in a virtual lab! Solve vehicle performance equations to unlock the door.

Puzzle 1: The Tractive Force Cipher

Clue 1: A vehicle ($m=1200\text{kg}$) needs to climb a 6° slope at 72 km/h .

Clue 2: Rolling resistance coefficient = 0.013

Clue 3: Frontal area = 2.1 m^2 , $C_d = 0.30$

Clue 4: Air density = 1.2 kg/m^3 , $g = 9.81\text{ m/s}^2$

Challenge: Calculate the required tractive force. The answer (in Newtons, rounded) is the passcode to the first lock.

Hidden Pattern: Notice something about the digits of your answer...

Puzzle 2: Transmission Ratio Riddle

Riddle:

"I help the engine sing its song,

In ratios weak or strong.

When starting slow, I must be low,

To make the twisting torque just flow.

At highway speeds, I shift up high,

To let the engine smoothly fly.

What am I, this clever part?

That matches power to moving cart?"

Answer: _____ (11 letters)

Game Mechanics:

- First puzzle: Numerical input with validation
- Second puzzle: Word puzzle with letter hints
- **Reward:** "Vehicle Dynamist Badge" and virtual test drive

MISSION 4: ENERGY SUPPLY CHAIN MAZE

Scenario:

Navigate energy from source to wheels through a maze with decision points.

Maze Paths:

text

START (Primary Energy)

- └─ Oil Well → Refinery → Gas Station → ICE Vehicle → WHEELS
- └─ Coal Mine → Power Plant → Grid → Charger → BEV → WHEELS
- └─ Solar Farm → Grid → Charger → PHEV → WHEELS
- └─ Natural Gas → Power Plant → Grid → Charger → FCEV → WHEELS

Challenges at Each Node:

1. **Efficiency Checkpoint:** Calculate energy losses at each conversion
2. **Environmental Checkpoint:** Identify pollution sources
3. **Economic Checkpoint:** Estimate cost per km

Puzzle: Find the most efficient path for:

- Minimum greenhouse gas emissions
- Maximum energy efficiency
- Lowest operating cost

Game Mechanics:

- Choose-your-own-adventure style
 - Each path has different scores
 - **Reward:** "Energy Strategist Badge" and resource management simulator unlock
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MISSION 5: COMPONENT MATCHING PUZZLE

Scenario:

Match vehicle components to their functions in a memory-card game.

Cards:

text

- [ICE] - [Provides torque at low RPM] ✗
- [Electric Motor] - [High starting torque] ✓
- [Transmission] - [Matches engine speed to wheel speed] ✓
- [Battery] - [Stores electrical energy] ✓
- [Power Split Device] - [Series-parallel hybrid core] ✓
- [Regenerative Braking] - [Recovers kinetic energy] ✓
- [Inverter] - [DC to AC conversion] ✓
- [Reduction Gear] - [Single-speed transmission for EVs] ✓

Game 1: Memory Match

- Flip cards to find pairs (Component - Function)
- Limited moves: 12 flips to complete 8 pairs

Game 2: Build Your Drivetrain

- Drag components to build:
 - Conventional ICE vehicle
 - Series HEV
 - Parallel HEV
 - BEV

Game Mechanics:

- Timer-based matching game
 - Drag-and-drop assembly
 - **Reward:** "Master Technician Badge" and virtual workshop tools
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MISSION 6: THE GRAND CHALLENGE - DESIGN YOUR HYBRID

Final Scenario:

You are the chief engineer at "SNS Electric Motors." Design a hybrid vehicle for Indian conditions.

Design Constraints:

- Budget: 15 lakh rupees
- Target: 30 km/liter equivalent

- Must handle Chennai traffic and occasional highway trips
- Must meet Bharat Stage VI emissions

Design Choices (Each affects performance):

1. **Battery Size:** 1 kWh (cost: 15k) to 20 kWh (cost: 3 lakh)
2. **Engine Size:** 1.0L (45kW) to 2.0L (100kW)
3. **Hybrid Architecture:** Series, Parallel, or Power-split
4. **Features:** Regenerative braking, solar roof, V2G capability

Optimization Puzzle:

Maximize this score: **Score = (Efficiency × 10) + (Range/10) - (Cost/1,00,000) - (Emissions × 100)**

Final Puzzle:

"What mathematical model from Unit 1 would you use to simulate your vehicle's performance before building a prototype?"

Game Mechanics:

- Resource management simulation
- Real-time performance feedback
- Peer comparison on leaderboard
- **Ultimate Reward:** "Chief Engineer Badge" and certificate of completion

ACHIEVEMENT SYSTEM

Badges to Earn:

1. **History Buff** - Complete Mission 1
2. **Eco Warrior** - Complete Mission 2
3. **Physics Pro** - Complete Mission 3
4. **Energy Guru** - Complete Mission 4
5. **Component Master** - Complete Mission 5
6. **Chief Engineer** - Complete Mission 6

Power-Ups:

- **Formula Sheet:** Unlocks after Mission 3
- **Simulation Tool:** Unlocks after Mission 5
- **Expert Mode:** Harder puzzles with GATE-level questions

Leaderboard Categories:

1. Speed Run - Fastest completion
2. Efficiency Expert - Best design score in Mission 6
3. Accuracy Master - Fewest errors
4. Collaboration Champion - Most peer helps

EDUCATIONAL OBJECTIVES MET THROUGH GAMIFICATION:

1. **Knowledge (Bloom's):** Missions 1 & 5 - Recall facts, match concepts
2. **Comprehension:** Missions 2 & 4 - Interpret data, explain concepts
3. **Application:** Missions 3 & 6 - Apply formulas, solve problems
4. **Analysis:** All missions - Compare systems, calculate impacts
5. **GATE Alignment:** Complex calculations in Missions 2, 3, 6

READY TO START YOUR HEV QUEST?

"The road to sustainable transportation begins with a single puzzle solved."

Game Design: EEE Department, SNSCT

Version: 1.0 - Gamified Learning Module