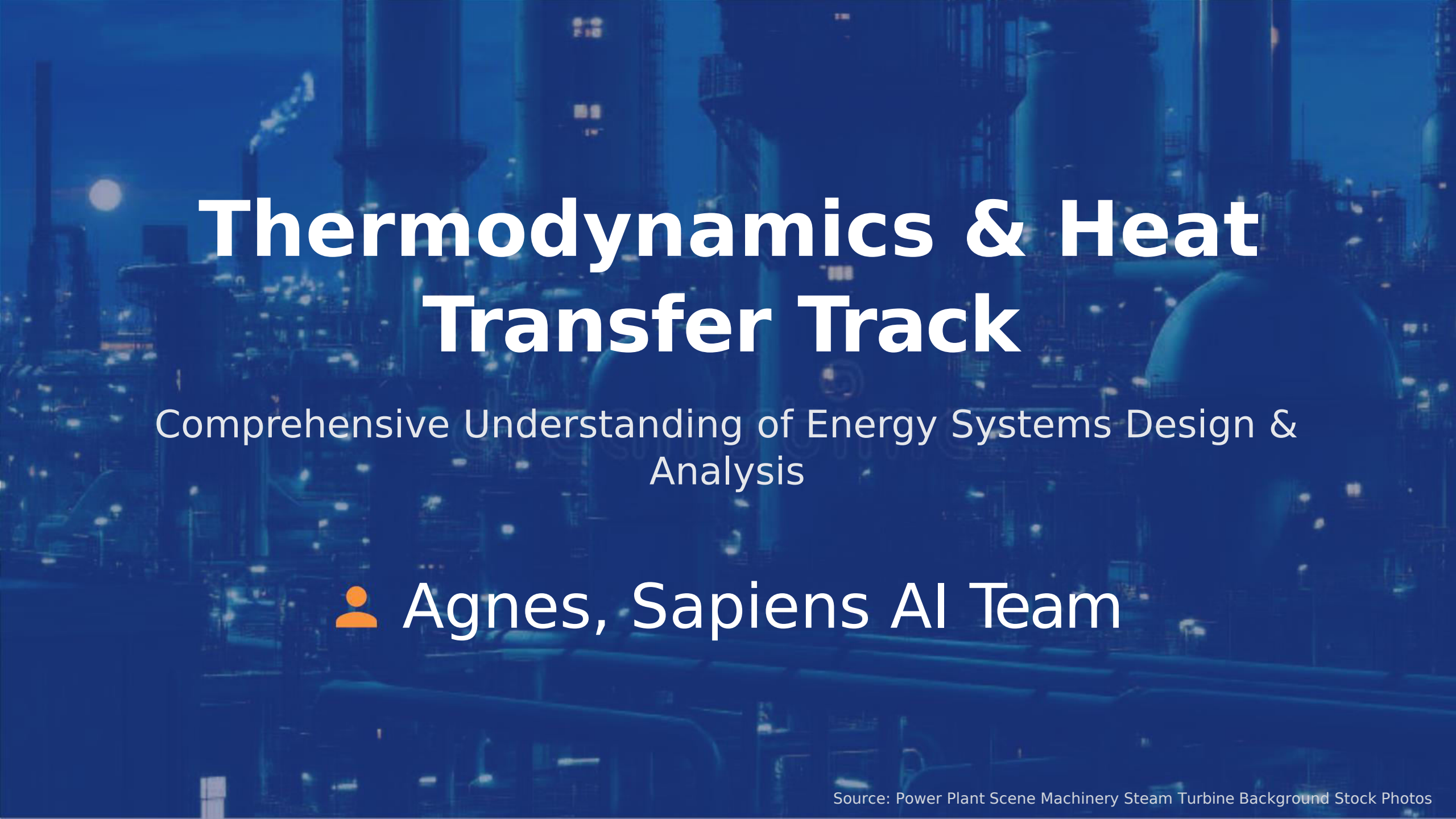


Thermodynamics & Heat Transfer Track

Comprehensive Understanding of Energy Systems Design & Analysis

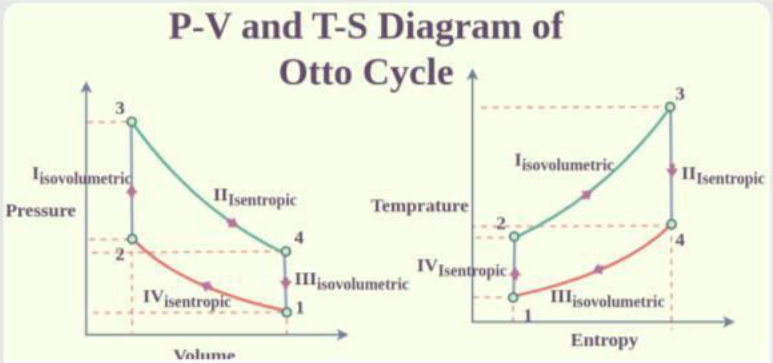
Agnes, Sapiens AI Team

Source: Power Plant Scene Machinery Steam Turbine Background Stock Photos

Program Overview & Core Topics

Program Goal: Design & Analyze Energy Systems

This program equips participants with essential skills to model and optimize energy systems through a deep dive into thermal engineering principles for efficient energy generation, conversion, and exchange.

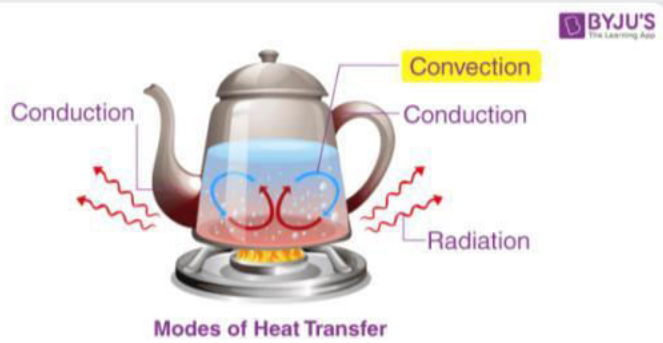


Thermodynamics Laws & Cycles

Fundamental Principles **Power Cycles**

Study of fundamental laws governing energy, entropy, and equilibrium in physical systems.

Focus on understanding cycles (Otto, Diesel, Rankine) used to transform heat

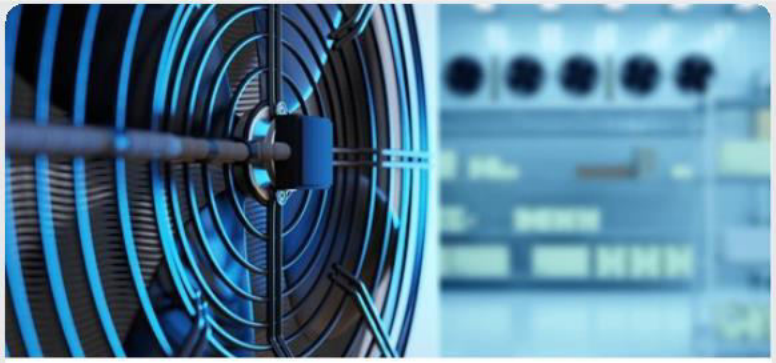


Heat Transfer Modes & Applications

Conduction **Convection** **Radiation**

Exploration of heat transfer mechanisms: conduction, convection, and thermal radiation.

Understanding how thermal energy flows is critical for designing diverse engineering



Refrigeration & AC Basics

Cooling Principles **Vapor Compression**

Introduction to the fundamental principles behind refrigeration and air conditioning systems.

Focus on vapor-compression cycles and their application in climate control and

Phase 1: Foundational & Core Concepts (Online)

Duration: Months 1 & 2 (Online Learning)

Month 1 Goal: Master Thermodynamics Fundamentals & Cycles

Energy Laws | System Behavior | Efficiency

Thermodynamics Principles: Delve into the fundamental laws governing energy, entropy, and equilibrium. Understand how these principles dictate the feasibility and limits of energy conversion.

Power Cycles: Focus on analyzing various thermodynamic cycles (e.g., Rankine, Otto, Diesel). Learn their application in heat engines and heat pumps for efficient work production.

Month 2 Goal: Understand Heat Transfer Modes & Applications

Conduction | Convection | Radiation | Thermal Exchange

Heat Transfer Mechanisms: Explore the three primary modes of thermal energy transfer: conduction, convection, and radiation. Analyze their characteristics in real-world systems.

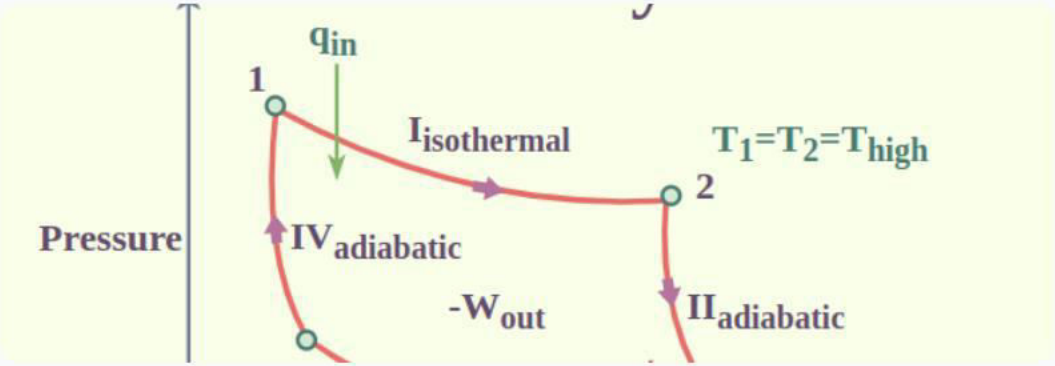
Engineering Applications: Apply principles to practical scenarios, including the design and optimization of heat exchangers, HVAC systems, and industrial processes where thermal exchange is critical.

Month 1: Thermodynamics Fundamentals

Goal: Master core laws, property analysis, and cycle principles.

Week 1: Introduction to Thermodynamics & Zeroth/First Law

Basic Concepts | Energy Balance | Hands-on

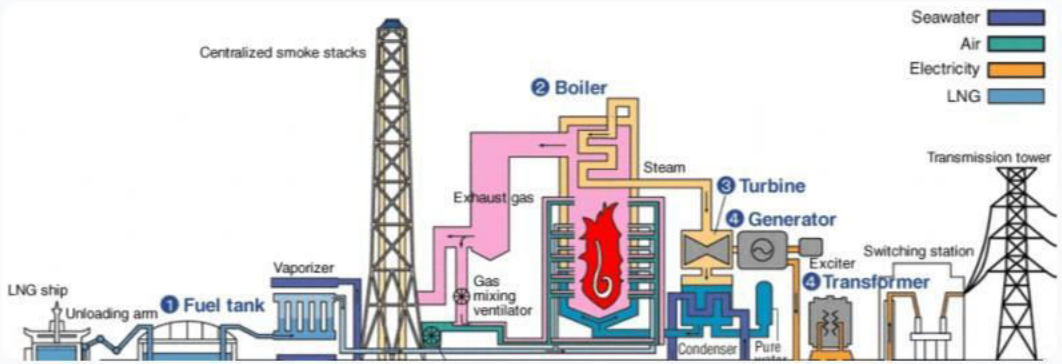


› Dive into core principles: systems, control volumes, state variables (P, T, V), and processes.

› Explore the Zeroth Law (thermal equilibrium) and master the First Law (energy conservation, heat/work transfer).

Week 2: Properties of Pure Substances & Steam Tables

Phase Diagrams | Property Tables | Ideal Gas Law | Hands-on



› Study properties of pure substances (water/steam) and learn to interpret phase diagrams (T-v, P-v).

› Develop proficiency using Steam Tables to determine thermodynamic states and properties.

› Understand and apply the Ideal Gas Law for analyzing

Month 1: Advanced Thermodynamics & Cycles

Deep Dive into Energy Principles & Power Generation

Week 3: Second & Third Law & Entropy

Entropy **Irreversibility** **Energy Quality**

Second Law: Explore its implications on heat transfer direction and the efficiency limits of thermal systems.

Entropy & Increase Principle: Understand entropy as a measure of disorder and why it increases in isolated systems during irreversible processes.

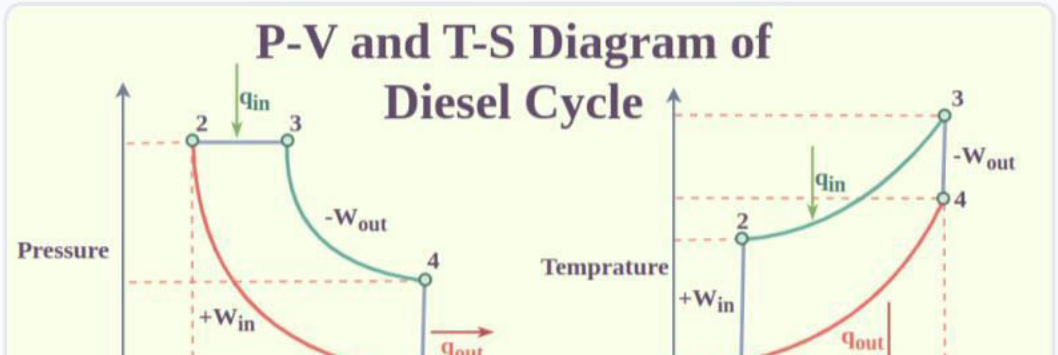
Hands-on Balance: Apply theory by performing entropy balance calculations for various thermodynamic systems in practical exercises.

Week 4: Thermodynamic Power Cycles

Carnot Cycle **Otto Cycle** **Rankine Cycle** **Efficiency**

Cycle Overview: Introduce key cycles (Carnot, Otto, Diesel, Rankine) that convert heat into work.

Process & Efficiency Analysis: Analyze processes (isobaric, isentropic, etc.) to evaluate thermal efficiency and performance.



Month 2: Heat Transfer Modes

Goal: Understand the mechanisms of heat flow.

Week 5: Conduction Heat Transfer

Fourier's Law | Thermal Resistance | Composite Walls | Steady State

🧪 Explore the primary mechanism of thermal energy transfer in solids through direct molecular contact.

Σ Master Fourier's Law to quantify heat

Week 6: Convection Heat Transfer

Newton's Law | Forced Convection | Natural Convection | Dimensionless Numbers

≋ Understand heat transfer via fluid motion, distinguishing between forced and natural convection.

🌡 Learn Newton's Law of Cooling and delve into

Month 2: Applied Heat Transfer & Project Scoping

Week 7: Radiation Heat Transfer

Blackbody Radiation | Emissivity | Combined Modes | Hands-on Calculations

Fundamentals: Explore thermal radiation as a primary mechanism of energy transfer via electromagnetic waves, crucial in forms like infrared radiation from hot objects.

Blackbody Radiation & Properties: Delve into the concept of a blackbody as an idealized emitter/absorber. Study key properties like emissivity and absorptivity for real surfaces.

Combined Heat Transfer: Analyze scenarios where radiation occurs with conduction and convection. Engage in hands-on calculations for complex systems to prepare for real-world challenges.

Week 8: Heat Exchangers & Refrigeration/AC Basics

Heat Exchangers & Insulation

Classification | LMTD | Insulation

Learn about devices for efficient thermal transfer between fluids, including classifications like shell-and-

Refrigeration & Project Scoping

VCR Cycle | Cooling Systems | Project Definition

Introduce the Vapor Compression Refrigeration (VCR) Cycle. Conclude with project scoping to define objectives

Phase 2: Industry Immersion & Integrated Project (Offline)

Program Duration

Month 3 | Offline Focus | Intensive

This critical phase is dedicated entirely to Month 3 of the program.

It emphasizes an immersive, full-time, offline engagement, departing from the online modules to offer a real-world work environment experience.

The Offline Capstone Project

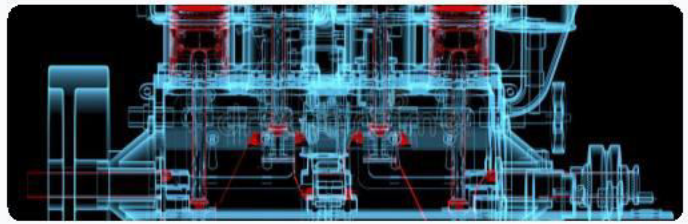
This intensive, full-time offline phase is the culmination of theoretical learning, integrating all acquired knowledge into a real-world engineering challenge and providing unparalleled industry immersion.

Core Project Goal

System Design | Engine Analysis

Participants will undertake a project focused on either:

- **Designing a System:** A novel heat exchanger or optimized energy plant.
- **Analyzing Engine Performance:** In-depth evaluation of an IC engine or power cycle.



Advanced Skill Demonstration

Career Readiness & Development

Month 3: Capstone Project - Setup & Implementation

Week 9: Project Kick-off & Detailed Design/Analysis Setup

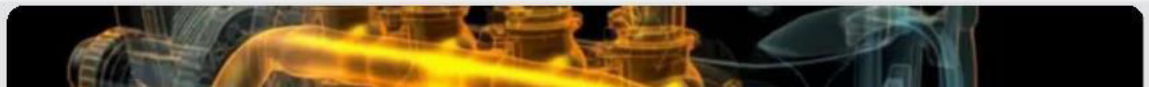
Team Formation | Project Scoping | Methodology Outline | Initial Analysis

Collaborative Foundation: Participants form interdisciplinary project teams, fostering collaboration. The initial phase involves selecting a capstone project that aligns with program objectives and team interests.

Strategic Planning: Teams develop a comprehensive project plan, outlining clear objectives, defining scope, and detailing methodologies. This includes specifying system parameters and preparing analytical frameworks.

Week 10: Implementation & Iterative Analysis

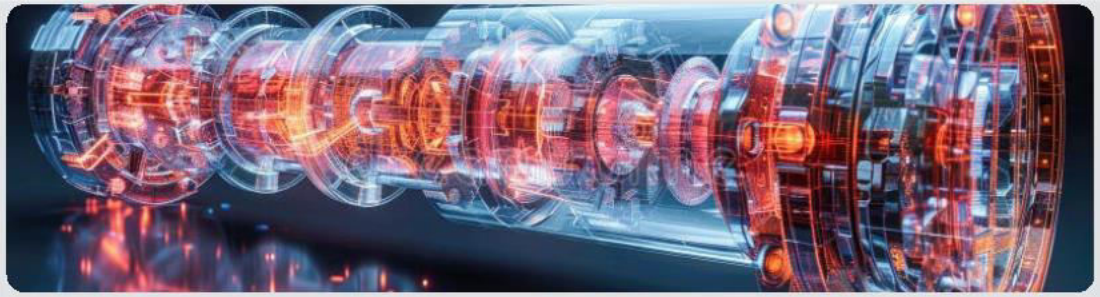
Thermal System Design | Performance Optimization | Cycle Analysis | Simulation



Month 3: Project Optimization & Reporting

Project Optimizat & Practica Considera

Material Selection | Fouling Mitigation | Efficiency Gains



Material Selection: Making critical decisions on materials based on thermal conductivity, corrosion resistance, and cost to ensure system performance and longevity.

Fouling & Friction: Mitigating the effects of deposit accumulation on heat transfer surfaces (fouling) and energy loss from friction, crucial for long-term operational efficiency.

Data Visualization & Technical Reporting

Clarity | Accuracy | Impact

Effective Data Visualization: Transforming complex thermal and performance data into clear, actionable visual insights using appropriate charts to highlight trends and comparisons.

Technical Report Generation: Structuring comprehensive reports that accurately convey project methodology, results, and conclusions, ensuring findings are clearly communicated.

Month 3: Project Showcase & Career Launchpad

Week 12: Final Project Presentation & Documentation

Methodology | Results | Insights | Technical Reporting

Comprehensive Project Presentation: Teams deliver a final, comprehensive presentation of their capstone projects, showcasing designs, analyses, and solutions to instructors and industry guests, covering detailed methodology and key findings.

In-depth Documentation: Submission of complete project documentation, including design specifications, simulation results, analytical models, and a robust discussion of insights. This serves as a tangible portfolio piece.

Q&A and Feedback: Engage in a dynamic Q&A session with experts, receiving valuable feedback on technical approaches and presentation skills to refine professional capabilities.

Career Development Workshops

Resume Building | LinkedIn Optimization | Interview Skills

Targeted Skill Enhancement: Intensive workshops focused on crafting compelling resumes, optimizing LinkedIn profiles for industry visibility, and mastering

Networking Session with Industry Professionals

Industry Connections | Mentorship | Career Insights

Direct Industry Engagement: An exclusive session to connect with leading professionals, facilitating idea exchange, potential mentorships, and direct insights into