🔥⚙️ Thermal Engineering Roadmap (12 Weeks)

🗓️ Week 1: Fundamentals of Thermodynamics

- Laws of Thermodynamics (0th, 1st, 2nd, 3rd).
- Concepts: system, boundary, process, cycle, state.
- Energy forms: internal energy, heat, work.

🗓️ Week 2: Properties of Pure Substances

- Phase diagrams: P-V, T-S, and H-S plots.
- Saturation temperature and pressure.
- Property tables: Steam tables, Mollier diagrams.

🗓️ Week 3: First Law for Closed and Open Systems

- Energy balance for closed systems.
- Steady-flow energy equation (SFEE).
- Application to nozzles, turbines, compressors.

🗓️ Week 4: Second Law of Thermodynamics

- Heat engines and refrigerators.
- Kelvin-Planck and Clausius statements.
- Carnot cycle and concept of reversibility.

🗓️ Week 5: Entropy and Exergy

- Entropy: definition and T-s diagrams.
- Clausius inequality and entropy change calculation.
- Exergy and Anergy; exergy efficiency.

🗓️ Week 6: Thermodynamic Cycles

- Otto, Diesel, Dual cycle (IC Engines).
- Brayton cycle (Gas Turbines).

- Rankine cycle (Steam power plants).

📅 **Week 7: Properties of Gases and Gas Mixtures**

- Ideal and real gases.
- Dalton's and Amagat's laws.
- Specific heat and gas constants for mixtures.

📅 **Week 8: Heat Transfer Modes**

- Conduction, convection, and radiation overview.
- Fourier's law and thermal conductivity.
- Steady and unsteady heat conduction.

📅 **Week 9: Convection Heat Transfer**

- Newton's Law of Cooling.
- Forced and natural convection.
- Nusselt number and empirical correlations.

📅 **Week 10: Radiation Heat Transfer**

- Stefan-Boltzmann Law, Kirchhoff's Law.
- Blackbody, gray body concepts.
- View factor, radiation shields.

📅 **Week 11: Heat Exchangers and Boilers**

- Types of heat exchangers: parallel, counter-flow.
- Effectiveness-NTU method.
- Boiler classification and performance indicators.

📅 **Week 12: Project / Case Study / Application**

- Heat exchanger design & simulation.
- Thermal analysis of an engine or component.
- Application: HVAC system design or solar thermal collector.

🛠️ **Tools You Can Use:**

- **MATLAB, ANSYS Fluent, SolidWorks Simulation**
- **EES (Engineering Equation Solver)**
- **Thermodynamic property tables / software calculators**