

CLAC360 PROFESSIONAL COURSE

PRACTICAL TRAFFIC ENGINEERING WITH AI

From Field Survey to Engineering Report

Learn Practical Professional Skills.
From Raw Observation to Defensible Engineering Decisions.

Course Code	CLAC-PTEAI-01
Course Type	Professional Applied Learning
Primary Delivery	PDF-based learning + practical assignments + quizzes + guided live sessions
Level	Intermediate to Professional
Discipline	Transportation / Traffic Engineering
Learning Orientation	Applied, analytical, evidence-based
Assessment Orientation	Competency and project-based
Core Product	Professional outcome, not content volume

PART I — COURSE IDENTITY

1. Course Premise

A traffic engineering study is not a collection of traffic counts, spreadsheets, charts and formulas.

It is an **evidence chain**.

A professional traffic engineer must be able to move logically through:

Problem → Question → Evidence → Survey → Data → Quality Control → Analysis → Interpretation → Engineering Judgment → Recommendation → Report

Artificial Intelligence can accelerate portions of this chain. It cannot replace the chain itself.

This course therefore does not teach learners to ask AI to “do traffic engineering.”

It teaches them to:

«use AI intelligently within a disciplined traffic-engineering workflow while retaining human responsibility for engineering decisions.»

2. The Course’s Central Proposition

The product is the outcome.

A learner should not finish this course merely saying: «“I completed 16 modules.”»

The intended result is:

«“I can plan a traffic study, collect or supervise traffic data, evaluate its quality, analyze it, use AI responsibly as a supporting tool, interpret the evidence, and produce a structured engineering report.”»

That distinction governs the entire course.

3. The CLAC360 Professional Learning Model

The course follows six stages:

LEARN	Understand the engineering concepts.
OBSERVE	Connect concepts to actual roadway conditions.
ANALYZE	Convert observations into measurable evidence.
VERIFY	Challenge data, calculations, assumptions and AI outputs.
PRODUCE	Create professional engineering work.
DEFEND	Explain why the methodology, findings and recommendations are reasonable.

The final stage is particularly important. A professional should be able to answer: «“Why did you reach this conclusion?”»

4. Intended Learner

This course is intended primarily for:

- transportation engineers;
- civil engineers;
- traffic engineers;
- highway engineers;
- transport planners;
- traffic survey supervisors;

- engineering consultants;
- road-agency technical staff;
- construction and infrastructure professionals;
- engineering graduates;
- researchers working with traffic data.

It can also serve experienced professionals who want to formalize or modernize their traffic-data workflow.

5. What This Course Does NOT Claim

This course does not:

- confer a professional engineering license;
- replace professional registration requirements;
- authorize a learner to approve regulated engineering work;
- replace project-specific specifications;
- replace applicable laws or regulations;
- replace the current edition of a governing standard or manual;
- guarantee competence for every traffic-engineering problem;
- treat AI output as professional approval;
- imply accreditation by a university, government agency, licensing authority or professional institution unless separately established.

The course teaches professional skills and applied methodology.

PART II — COMPETENCY FRAMEWORK

6. Course Learning Outcomes

Upon successful completion, the learner should be able to:

C1 — Define	Translate a traffic problem into a clear engineering study question.
C2 — Plan	Develop a defensible traffic-data collection strategy.
C3 — Observe	Design practical field observations appropriate to the study objective.
C4 — Collect	Collect or supervise traffic data using consistent procedures.
C5 — Validate	Identify potential errors, anomalies, gaps, inconsistencies and atypical conditions.
C6 — Process	Transform raw observations into structured analytical datasets.
C7 — Calculate	Perform appropriate traffic-engineering calculations.
C8 — Analyze	Use tables, statistics, charts and engineering methods to identify meaningful patterns.
C9 — Interpret	Distinguish numerical results from engineering meaning.
C10 — Use AI	Apply AI to suitable supporting tasks while controlling its risks and limitations.
C11 — Verify	Independently check calculations, AI-generated content, assumptions and sources.
C12 — Recommend	Develop evidence-linked engineering recommendations.
C13 — Report	Prepare a professional traffic-engineering report.
C14 — Defend	Explain and justify the methodology and conclusions.

7. The Evidence Ladder

Every major conclusion in the course should be traceable through:

Source → Observation → Data → Calculation → Result → Interpretation → Decision

This becomes the course's Evidence Ladder.

For example:

Field observation ↓
 Raw traffic count ↓
 Clean dataset ↓
 Peak-hour calculation ↓
 Peak-period result ↓
 Operational interpretation ↓
 Engineering implication ↓
 Recommendation

If one of these links is missing, the conclusion becomes weaker.

PART III — COURSE ARCHITECTURE

MODULE 00 — PROFESSIONAL MINDSET

From “Counting Traffic” to “Producing Evidence”

Topics

- What traffic engineering actually involves
- Why good analysis begins before field data collection
- Difference between data collection and engineering investigation
- Engineering judgment vs. mathematical calculation
- Why technically correct calculations can still produce poor decisions
- Evidence, assumptions and uncertainty
- The role of professional documentation

«A calculation is only as useful as the question it answers and the data supporting it.»

Practical task

Given three traffic problems, identify: what is known; what is unknown; what must be measured; what should not be assumed.

MODULE 01 — DEFINING THE TRAFFIC PROBLEM

From Complaint to Engineering Question

Traffic studies often begin with statements such as: “This intersection is congested.” “Vehicles are moving too fast.” “There is too much traffic.” “Pedestrians cannot cross safely.” “Parking is causing problems.” These are problem statements, not yet engineering questions.

Topics

- Problem definition
- Stakeholder statements vs. measurable questions
- Study objectives
- Performance questions
- Spatial boundaries
- Temporal boundaries
- Required evidence
- Study hypotheses

Professional Framework

Convert: «“The intersection is congested.”» into questions such as: When does congestion occur? Which approach experiences it? How long does it persist? Which movements contribute to it? What are the observed queues? What traffic demand exists during the affected period? What other factors may contribute?

Deliverable: Traffic Study Problem Definition Sheet

MODULE 02 — STUDY DESIGN

Designing the Investigation Before Collecting Data

Topics

- Study scope
- Study area
- Survey locations
- Survey duration
- Observation periods

- Day selection
- Special events
- Weather
- Seasonal effects
- Survey resources
- Observer requirements
- Equipment
- Contingency planning

Traffic-monitoring guidance emphasizes that data needs should drive program design and that traffic data serve different purposes depending on the intended use.

Critical Question: «What decision will this dataset eventually support?» If the answer is unclear, the survey design should be reconsidered.

Deliverable: Traffic Engineering Study Plan

MODULE 03 — SELECTING THE RIGHT SURVEY

Not Every Traffic Problem Requires the Same Data

Survey families

- classified traffic volume
- turning movement
- pedestrian
- bicycle/micromobility
- speed
- travel time
- parking
- queue
- origin-destination
- roadside/access activity
- conflict observations where appropriately designed
- automated traffic monitoring

Decision Matrix

Engineering question	Potential data
How much traffic?	Volume
What vehicles?	Classification
Where do vehicles turn?	Turning movement
How fast?	Speed
How long does travel take?	Travel time
Where are pedestrians moving?	Pedestrian observation
How much parking occurs?	Parking survey
Where does traffic come from/go?	O-D study
How long are queues?	Queue observation

«Collect the minimum sufficient data required to answer the engineering question—not every possible dataset.»

MODULE 04 — FIELD SURVEY DESIGN

Turning a Method into a Repeatable Field Procedure

Topics

- survey station selection
- observer positioning
- field-sheet design
- coding systems
- vehicle classification
- interval selection
- direction coding
- movement coding
- clock synchronization
- field instructions
- observer training
- safety
- field communications

Every observer should understand: «What counts? Where? When? Under which category? What happens when classification is uncertain?»

Deliverables: Field Survey Instruction Sheet; Observer Briefing Sheet; Survey Station Plan; Field Data Collection Sheet

MODULE 05 — TRAFFIC DATA COLLECTION

From Roadway to Raw Dataset

5.1 Classified Traffic Counts — Record: time; direction; vehicle category; count.

5.2 Turning Movements — Record: approach; movement; vehicle class; time interval.

5.3 Pedestrians and Cyclists — Record: direction; crossing location; movement; time; relevant characteristics.

5.4 Speed Observations — Record: observation; time; direction; speed; location; relevant vehicle information.

5.5 Parking — Potential observations: occupancy; accumulation; duration; turnover; location; obstruction.

«The field sheet is part of the analytical system, not merely a piece of paper.»

MODULE 06 — DATA QUALITY ENGINEERING

The Most Important Module in the Course

Traffic data can be numerically precise and still be wrong. Professional traffic-data programs therefore require documented QA/QC procedures. FHWA specifically emphasizes that data quality involves more than correcting data, and that atypical observations should not simply be discarded because they look unusual.

6.1 Types of Data Problems

- missing observations
- duplicate observations
- incorrect timestamps
- inconsistent classifications
- transcription errors
- impossible values
- equipment malfunction
- observer error
- temporary incidents
- abnormal weather

- roadworks
- special events
- unusual demand

6.2 Valid vs. Typical

This distinction is critical. A value can be: unusual but valid — or — apparently normal but invalid.

6.3 The Data-Quality Decision Tree

For every anomaly: Detect → Investigate → Classify (valid / invalid / uncertain / atypical / missing) → Document → Determine treatment → Retain audit trail

6.4 Never Silently Clean Data

Every material modification should have: original value; modified value; reason; method; reviewer; date.

Deliverable: Data Quality & Cleaning Log

MODULE 07 — TRAFFIC DATA STRUCTURE

Building an Analysis-Ready Dataset

Topics

- raw data
- metadata
- variable names
- units
- coding
- missing values
- observation intervals
- unique identifiers
- version control
- data dictionaries

Recommended architecture

RAW (untouched original observations) → QC (validation checks) → CLEAN (approved analytical dataset) → CALC (formulas and derived variables) → OUTPUT (tables/charts) → REPORT (final communication)

«Never overwrite the raw dataset.»

MODULE 08 — TRAFFIC VOLUME ANALYSIS

From Counts to Meaningful Demand Measures

Topics

- interval volume
- hourly volume
- directional volume
- approach volume
- daily volume
- classification distribution
- directional split
- temporal profiles
- peak-period identification

Peak-Hour Factor

$$PHF = V / (n \times V_{\text{peak}})$$

where: V = volume during the analysis hour; V_{peak} = highest subinterval volume; n = number of subintervals within the hour.

The learner must understand: formula → calculation → meaning → limitation — rather than simply memorize the formula.

MODULE 09 — VEHICLE CLASSIFICATION & PCU

Converting Heterogeneous Traffic into Analytical Information

Topics

- classification systems
- local vehicle mix
- heavy vehicles
- motorcycles
- buses
- commercial vehicles
- passenger-car-unit concepts
- assumptions
- context dependence

Critical analytical question: «Is the selected equivalency appropriate for the methodology and context being used?»

The course explicitly discourages treating a single conversion factor as universally valid.

MODULE 10 — TURNING MOVEMENT & INTERSECTION ANALYSIS

Topics

- intersection approaches
- movement coding
- through movements
- turning movements
- U-turns
- directional distribution
- peak movement
- queue observations
- blocking
- pedestrian interaction

- access interference

Analytical progression

Movement count → Movement distribution → Dominant movement → Observed operational condition → Potential issue → Further engineering analysis

The course avoids the simplistic assumption that: «High volume = inadequate intersection.»

MODULE 11 — SPEED & TRAVEL-TIME ANALYSIS

Topics

- speed distributions
- descriptive statistics
- percentiles
- variability
- time periods
- directional differences
- travel time
- delay
- reliability concepts
- limitations of short-duration observations

Critical distinction: Average speed does not automatically describe safety, congestion, operating quality, speed compliance, or design suitability. The learner must connect the statistic to the question it is intended to answer.

MODULE 12 — PEDESTRIAN, BICYCLE & PARKING ANALYSIS

Topics

- pedestrian demand
- crossing patterns
- bicycle movements
- micromobility
- parking accumulation
- occupancy
- duration
- turnover
- roadside activity
- multimodal interaction

Traffic monitoring has expanded beyond motor vehicles to include micromobility and pedestrian data, reflecting the broader information needs of modern transportation systems.

«Traffic operations are multimodal interactions, not simply vehicle counts.»

MODULE 13 — TRAFFIC ANALYSIS WITH SPREADSHEETS

Engineering Data, Not Spreadsheet Decorations

Workbook architecture

00_README → 01_RAW_DATA → 02_DATA_DICTIONARY → 03_QC → 04_CLEAN_DATA → 05_CALCULATIONS → 06_TABLES → 07_CHARTS → 08_SUMMARY

Topics

- formulas
- validation
- lookup functions
- conditional logic
- pivot tables
- charts
- automated checks
- error flags
- reproducibility
- auditability

«Every reported number should be traceable to its source.»

MODULE 14 — VISUAL ANALYTICS

Making Traffic Data Visible

Visual tools

- hourly profiles
- directional charts
- vehicle-class distributions
- turning-movement diagrams
- speed distributions
- cumulative distributions
- parking accumulation profiles
- pedestrian-flow profiles

A chart is not automatically useful because it looks professional. Every figure should answer: «What engineering question does this figure help the reader answer?»

MODULE 15 — AI FUNDAMENTALS FOR TRAFFIC ENGINEERS

What AI Is—and What It Is Not

Topics

- generative AI
- large language models
- structured-data assistance
- pattern recognition
- prompt design
- hallucination
- uncertainty
- source verification
- privacy
- confidentiality
- reproducibility

AI's proper role

AI can be: assistant, reviewer, organizer, drafting aid, coding assistant, exploration tool. It is not automatically: engineer, authority, standard, or source of truth.

MODULE 16 — THE AI TRAFFIC-ENGINEERING WORKFLOW

Ask → Inspect → Verify → Use

The course establishes a formal AI workflow:

STEP 1 — DEFINE	What exactly is the task?
STEP 2 — PREPARE	What data and context are available?
STEP 3 — PROMPT	Give AI a precise task and constraints.
STEP 4 — INSPECT	Examine the output critically.
STEP 5 — VERIFY	Check calculations, sources and logic independently.
STEP 6 — INTEGRATE	Use only verified information.
STEP 7 — DOCUMENT	Record significant AI assistance where appropriate.
STEP 8 — RETAIN ACCOUNTABILITY	The professional remains responsible for the final work.

This human-oversight approach aligns with broader AI risk-management principles emphasizing trustworthy use and management of AI risks.

MODULE 17 — AI FOR DATA QUALITY

AI can assist in identifying: missing intervals; duplicate records; unusual values; inconsistent labels; suspicious patterns; formatting errors. But the AI output is treated as a «Potential anomaly list» — not a «Final data-cleaning decision.»

Practical exercise

Provide AI with a deliberately corrupted dataset. Ask it to identify possible problems. Then require the learner to classify each AI finding:

AI finding	Genuine issue?	Evidence	Final treatment
Missing interval	Yes	Field log	Flagged
High volume	No	Field notes	Retained
Duplicate	Yes	Record ID	Corrected

This teaches AI verification, not AI dependence.

MODULE 18 — AI FOR ENGINEERING CALCULATIONS

AI may assist with: spreadsheet formulas; coding logic; calculation explanations; unit conversions; automated checks; repetitive transformations.

Mandatory verification

Every AI-generated calculation must be checked through: independent calculation; spreadsheet verification; dimensional/unit check; boundary-value or reasonableness check; source-method check.

«Never accept an engineering calculation merely because the AI explanation sounds convincing.»

MODULE 19 — AI FOR ENGINEERING INTERPRETATION

AI can generate possible interpretations. The learner must then ask:

- Is the interpretation supported by the data?
- Does it answer the study question?
- Does it introduce assumptions?
- Does it confuse correlation with causation?
- Does it ignore contradictory evidence?
- Does it exceed the data's limitations?
- Does it require additional field investigation?

Output classification

Every AI-generated statement should be classified as: Verified fact | Calculated result | Professional interpretation | Hypothesis | Unsupported claim. This becomes one of the course's distinctive analytical techniques.

MODULE 20 — AI FOR ENGINEERING REPORTING

AI may assist with: report structure; grammar; clarity; table descriptions; executive-summary drafting; formatting; alternative explanations. But the engineer controls: factual accuracy; calculations; methodology; references; assumptions; conclusions; recommendations.

Recommended workflow

Verified evidence → Verified calculations → Engineer-approved findings → AI-assisted drafting → Human technical review → Final report

MODULE 21 — STANDARDS, REFERENCES & METHODOLOGY CONTROL

The Reference Hierarchy

The learner must distinguish between:

1. applicable law/regulation

2. project requirements
3. governing authority standards/manuals
4. recognized engineering methodologies
5. technical literature
6. professional judgment
7. AI-generated suggestions

«AI is never promoted above the governing technical source.»

Where methodologies differ, the learner must identify: source; edition; jurisdiction; applicability; assumptions. Traffic-data methodologies and QA/QC practices vary by program and jurisdiction; contemporary guidance such as FHWA's Traffic Monitoring Guide should therefore be treated as a reference framework, not automatically as the governing standard for every project.

MODULE 22 — FROM DATA TO ENGINEERING JUDGMENT

The Five-Layer Interpretation Model

For every major finding the course develops a structured five-layer interpretation approach that moves systematically from observed data through calculation, contextual factors, professional judgment, and finally to defensible recommendations. This module reinforces that numerical results alone do not constitute engineering conclusions; interpretation, uncertainty management, and clear documentation of assumptions are essential professional responsibilities.

End of Course Outline — CLAC360 Practical Traffic Engineering with AI (CLAC-PTEAI-01)
Professional outcome, not content volume. Evidence-based. Human-accountable AI use.