University of Alberta
Department of Civil and Environmental Engineering
College of Engineering

CIV E 616 – Road Traffic Safety

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Office Hours: Monday and Wednesday, 10:00 AM-12:00 PM.
Course: CIV E 616 - Road Traffic Safety.
Term: Winter 2027.
Class Time: Tuesday, 2:00–4:50 PM (To be confirmed).
Delivery Mode: Online / In-person / Hybrid (To be confirmed).
Location: To be confirmed.

Course Overview

In this course, you will explore the principles, methods, and practical applications of road traffic safety analysis. The course introduces the global and Canadian context of road safety, the evolution of traffic safety thinking, the limitations of crash data, safety performance measurement, and the traffic safety management process.

The course is structured around the main stages of the road safety management process: network screening, diagnosis, remedy or countermeasure selection, economic appraisal, project prioritization, and evaluation of implemented countermeasures. Through this process, you will learn how transportation professionals identify high-risk locations, diagnose contributing factors, select appropriate countermeasures, and evaluate whether safety improvements are effective and economically justified.

The course covers conventional safety analysis techniques, Bayesian analysis methods, safety performance functions, crash modification factors, safety evaluation methods, and economic evaluation. It also introduces emerging data-driven approaches, including GIS-based safety analysis, machine learning applications, video analytics, and automated safety assessment tools.

Through homework assignments, participation activities, numerical exercises, and a term project, you will apply traffic safety methods to real-world problems. By the end of the course, you should be able to interpret crash and exposure data, evaluate safety performance, recommend evidence-based interventions, and communicate safety findings clearly to technical and policy audiences.

Important Notes

Item	Details
Term	Winter 2027
Target Students	Graduate students in civil, transportation, urban planning, and related fields with an interest in traffic safety and road safety analysis
Prerequisites	Basic knowledge of transportation engineering; introductory probability/statistics recommended
Software	Excel, Python/Google Colab, GIS tools, and statistical software may be used for selected assignments and project analysis
Class Time	Tuesday, 2:00–4:50 PM
Location	To be confirmed

Core Course Question	How can road safety data, statistical methods, and engineering judgment be used to diagnose traffic safety problems, select effective countermeasures, and evaluate whether safety improvements are justified and effective?

Course Objectives:

This course aims to:

1. Introduce students to the global, Canadian, and local context of road traffic safety and the societal burden of crashes.
2. Develop students' understanding of the traffic safety paradigm shift, including nominal versus substantive safety and the movement toward proactive and systemic safety management.
3. Introduce students to the traffic safety management process, including network screening, diagnosis, remedy selection, economic appraisal, prioritization, and evaluation.
4. Provide students with practical knowledge of crash data, exposure measures, crash modification factors, surrogate safety measures, and the limitations of crash-based safety analysis.
5. Develop students' ability to apply conventional and Bayesian traffic safety analysis methods.
6. Introduce students to safety performance functions, crash prediction models, and the statistical foundations used in road safety analysis.
7. Develop students' ability to evaluate the effectiveness and economic justification of safety countermeasures.
8. Provide students with applied experience in reviewing traffic safety data and preparing evidence-based safety recommendations.

Intended Learning Outcomes:

LO	Description
LO1	Explain key traffic safety concepts, including crash frequency, severity, exposure, risk, safety performance, and the evolution of safety thinking.
LO2	Describe the global, Canadian, and local context of road safety and explain the role of institutional capacity in improving safety outcomes.
LO3	Apply the traffic safety management process to identify, diagnose, and prioritize safety problems.
LO4	Use conventional and Bayesian safety analysis methods to interpret crash data and evaluate roadway safety performance.
LO5	Develop, interpret, or critically assess safety performance functions, crash modification factors, and countermeasure evaluation results.
LO6	Conduct economic evaluation of safety countermeasures using concepts such as present worth, equivalent annual worth, benefit-cost ratio, and cost-effectiveness.
LO7	Conduct a safety review of a selected site or corridor and propose evidence-based countermeasures supported by data analysis and engineering judgment.
LO8	Communicate traffic safety findings through technical writing, numerical analysis, and professional presentations.

Course Outline:

Week	Phase	Topic	Details	Milestone
Week 1	Foundations	Course Overview and Global Traffic Safety Problem	Course structure, expectations, global road safety burden, injury prevention context, and the role of traffic safety analysis	Participation 1

Week 2		Canadian Traffic Safety Context and Institutional Capacity	Canadian road safety trends, Edmonton traffic safety context, institutional capacity, and the role of engineering, enforcement, education, and evaluation	Participation 2
Week 3		Traffic Safety Paradigm Shift	Nominal vs. substantive safety, proactive safety management, predictable and preventable crashes, Haddon matrix, and safety measures	HW 1 assigned; Participation 3
Week 4		Fundamentals of Traffic Safety	Crash frequency, severity, crash rates, exposure, safety assessment tools, CMFs, surrogate safety measures, and limitations of crash data	HW 1 due; HW 2 assigned
Week 5	Safety Management	Safety Management Process	Network screening, diagnosis, countermeasure selection, economic appraisal, prioritization, and evaluation	HW 2 due; Project topic selection
Week 6	Project Development	Term Project Information and Safety Diagnosis	Project scope, data sources, site selection, descriptive statistics, collision diagrams, condition diagrams, operational analysis, and diagnosis of contributing factors	Project proposal due
Week 7	Analysis Methods	Conventional Safety Analysis Methods	Crash frequency, crash rate, crash severity, confidence intervals, statistical quality control, random crash fluctuation, and regression-to-the-mean	HW 3 assigned
Week 8	Break	Reading Week / No Class	Independent reading and project development	—
Week 9	Statistical Foundations	Statistics Overview for Traffic Safety	Descriptive and inferential statistics, central tendency, variation, probability rules, and distributions including Poisson, binomial, gamma, beta, and negative binomial	HW 3 due; HW 4 assigned
Week 10	Analysis Methods	Bayesian Safety Analysis	Empirical Bayes concepts, observed vs. expected crashes, crash over-dispersion, regression-to-the-mean, and uncertainty in safety estimation	HW 4 due
Week 11	Predictive Safety	Safety Performance Functions	Crash prediction models, nonlinear exposure relationships, site characteristics, model interpretation, and applications of SPFs	HW 5 assigned
Week 12	Evaluation	Safety Evaluation Methods and Economic Evaluation	Before-after studies, comparison groups, empirical Bayes evaluation, CMFs, benefit-cost analysis, present worth, annual worth, and economic justification	HW 5 due; HW 6 assigned
Week 13	Assessment	Project Review and Numerical Quiz	Review of key numerical concepts, safety management applications, economic evaluation, Bayesian analysis, and SPF interpretation	HW 6 due; Numerical quiz
Week 14	Communication	Term Project Presentations	Presentation of safety diagnosis, analysis methods, countermeasures, economic appraisal, and recommendations	Final presentation
Week 15	Wrap-Up	Course Reflection and Emerging Data-Driven Traffic Safety Applications	GIS-based safety analysis, machine learning, video analytics, automated safety assessment, and future directions	Final project report due

Weighted Assessment Plan:

Assessment Item	Description	Due Time	Weight	Learning Outcomes
Participation: In-Class / Online Activities	Short weekly activities, discussions, article reflections, safety case reviews, short written/video responses, or annotated notes related to current modules	Weekly / selected weeks	10%	LO1, LO2, LO8
Homework Assignments	Numerical and written assignments covering crash data, exposure, conventional methods, statistics, Bayesian analysis, SPFs, CMFs, safety evaluation, and economic appraisal	Throughout term	35%	LO1, LO3, LO4, LO5, LO6
Case Study / Article Review	Critical review of a traffic safety study, countermeasure evaluation, policy document, or safety program, focusing on data, methods, assumptions, limitations, and practical relevance	Week 5 or 6	10%	LO2, LO5, LO8
Term Project Proposal	Short proposal identifying the selected location or safety problem, available data, project scope, planned diagnosis approach, and expected countermeasure direction	Week 6	5%	LO3, LO7
Term Project Report	Safety review of a selected high-collision location, corridor, or safety problem. Includes data review, descriptive statistics, collision/condition diagrams where applicable, diagnosis, countermeasure selection, economic appraisal, and recommendations	End of term	20%	LO3, LO4, LO5, LO6, LO7, LO8
Term Project Presentation	Professional presentation of project methods, findings, diagnosis, countermeasures, economic justification, and recommendations	Week 14	10%	LO7, LO8
Numerical Quiz / Exam	Assessment of quantitative safety analysis skills, including crash rates, expected crashes, regression-to-the-mean, empirical Bayes concepts, SPFs, CMFs, and economic evaluation	Week 13	10%	LO3, LO4, LO5, LO6
Total			100%	

Participation Activities

Participation activities are designed to support continuous engagement with the course material. Activities may include:

- Finding and briefly summarizing a relevant traffic safety article, report, or case study.
- Submitting handwritten or annotated notes for selected modules.
- Writing a short reflection on a traffic safety issue, countermeasure, or policy debate.
- Posting a short video or written response explaining a key concept.
- Participating in case-based discussions, numerical exercises, and group activities.

Participation submissions will be required for selected modules rather than for every class. Detailed instructions will be provided in class.

Term Project

The term project will require students to conduct a traffic safety review of a selected high-collision location, corridor, or safety issue. The project should demonstrate the ability to apply the traffic safety management process and translate data analysis into practical recommendations.

Possible project components include:

1. Study location or safety problem definition.
2. Safety data review and summary.
3. Descriptive statistics of crash patterns, including time of day, day of week, month, crash type, severity, road condition, lighting condition, weather condition, and contributing circumstances where data are available.
4. Collision diagrams and/or condition diagrams, where applicable.
5. Operational or contextual analysis of the site or corridor.
6. Identification of safety issues and contributing factors.
7. Selection and justification of potential countermeasures.
8. Economic, practical, or policy-based appraisal of recommended treatments.
9. Final report and professional presentation.

The term project is intended to connect the course topics to real-world safety decision-making, including diagnosis, remedy selection, economic appraisal, project prioritization, and evaluation.

Grading Scale*

Percentage	Grade	Percentage	Grade
96–100	A+	68–72	C+
92–95	A	63–67	C
88–91	A-	58–62	C-
83–87	B+	54–57	D+
78–82	B	50–53	D
73–77	B-	0–49	F

**Final grade cutoffs may be subject to minor adjustments based on overall class performance and university guidelines*.

Accessibility and Support

Lecture materials will be shared in advance where possible, and key concepts will be explained using multiple approaches, including visual demonstrations, worked numerical examples, case studies, and applied safety review exercises. The course supports students with varying technical and statistical backgrounds through progressive learning, guided examples, and opportunities for feedback.
The term project will allow flexibility in selecting safety problems or locations that align with students' interests. Support will be available during office hours, by appointment, and through feedback on project milestones. Students requiring accommodation will be supported in accordance with university policy.

Generative AI and academic integrity

This course adopts a transparent and responsible approach to the use of generative AI tools. Students may use AI tools, such as ChatGPT, coding assistants, or grammar support tools, for brainstorming, conceptual clarification, coding support, and writing refinement, provided that their use is clearly acknowledged.

AI tools must not replace students' own understanding, calculations, interpretation, or engineering judgment. Students are responsible for verifying all AI-assisted outputs and ensuring that submitted work reflects their own reasoning and learning.

Students may use AI tools to:

- Brainstorm project ideas or refine problem statements.
- Clarify theoretical concepts.
- Debug code or understand software errors.
- Improve writing clarity and grammar without changing technical meaning.

Students should not use AI tools to:

- Generate full assignment solutions without understanding.
- Produce final project interpretations or recommendations without verification.
- Replace their own reasoning in model selection, safety diagnosis, or engineering judgment.

Any use of AI tools must be briefly documented in an appendix or statement of use, including the tool used and the purpose of use.

Textbook and Reference Materials

There is no required textbook. Lecture notes, readings, assignments, datasets, and supporting materials will be posted on eClass.

Recommended references include:

- AASHTO. *Highway Safety Manual*.
- FHWA. *Road Safety Fundamentals*.
- NHTSA. *Countermeasures That Work: A Highway Safety Countermeasures Guide*.
- ITE. *Traffic Engineering Handbook*.
- Crash Modification Factors Clearinghouse.
- NCHRP Report 501. *Integrated Safety Management Process*.
- NCHRP Report 500. *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan*.
- PIARC. *Road Safety Manual*.