Indian Institute of Technology Kanpur
New Course Proposal

1. **Course No:** CE 714

2. **Course Title:** Traffic Dynamics and Simulation

3. **Per Week Lectures (TBD):** 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours [0-2]: 0 (A)
   Credits: 9 **Duration of Course:** Full Semester

4. **Proposing Department/IDP:** Civil Engineering
   Other Departments/ODPs which may be interested in the proposed course: Physics and Mathematics
   Other faculty members interested in teaching the proposed course: N/A

5. **Proposing Instructor(s)**: Venkatesan Kanagaraj

6. **Course Description:**
   (a) *Objectives:* This course will provide a basic understanding of macroscopic models such as the first-order and higher-order traffic flow models, model characteristics, and numerical schemes. Microscopic models such as car-following and lane-changing models will be discussed. Development of traffic simulation, calibration, and validation of simulation will be presented. Finally, the course discusses disordered traffic, macroscopic and microscopic models for disordered traffic, and its implementation in traffic simulation.

   (b) Contents:

S. No.	Broad Title	Topics	Lectures
1	First-order models	Traffic variables, Hydro-dynamics relationship, Eulerian and Lagrangian formulation of continuity equations, LWR Model, Method of characteristics, Shockwave speed derivations, shockwave, and expansion wave analysis.	8
2	Second-order models	Macroscopic Acceleration Function, Properties of the Acceleration Function, Payne's model and Jiang's model, Characteristic speeds of models, and Linear stability analysis.	6
3	Numerical scheme	Finite difference and Finite volume method, Cell transmission model using triangular fundamental diagrams. Solving higher-order models using Upwind and McCormack Scheme.	6
4	Microscopic models	Model criteria, Optimal velocity model, Newell's car following model, Gipps model, Intelligent driver model, Steady-State Equilibrium criteria, Linear stability analysis, and MOBIL- lane changing models.	8
5	Traffic simulation	Development of traffic simulation, Calibration and validation of simulation models, and Applications of traffic simulation.	6

6	Disordered traffic	First-order and second-order model for disordered traffic and its numerical scheme. Microscopic model – self-driven particle model and implementation in the traffic simulation.	6
		Total	**40**

(c) *Recommended prerequisites*: Basic knowledge of partial differential equations, numerical techniques, and programming skills are required.

(d) *Short summary for including in the courses of study booklet:* Eulerian and Lagrangian form of the continuity equation; First-order models: method of characteristics, shock wave and expansion wave analysis; Second-order models: numerical scheme and CTM models with triangular fundamental diagrams; Microscopic models: car-following and lane-changing models, linear stability analysis, traffic simulation, calibration and validation of simulation models; Traffic flow models and simulation for disordered traffic.

7. **Recommended Books:**

Textbooks:

Treiber, M. & Kesting, A., (2013). "Traffic flow dynamics: data, models and simulation.", Springer.

Reference Books:

Ni, D. (2015). "Traffic flow theory: characteristics, experimental methods, and numerical techniques. ", Elsevier.

Boris S. Kerner (2004) "The physics of traffic: empirical freeway pattern features, engineering applications, and theory", Springer,

May A.D. (1990). "Traffic flow fundamentals.", Prentice-Hall, New Jersey.

Additional Resources: Nil

8. **Other Remarks:** Nil

Dated: 18/02/2024 Proposer: Venkatesan Kanagaraj

Dated: _____ DUGC/DPGC Convener: _____

✓

The course is approved / not approved

28/3/24

Chairman ~~SUGC~~/SPGC

Dated: _____