GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil Engineering (Transportation Engineering)

Course/Subject Code: ME02069041

Course/Subject Name: Traffic Flow Theory and Simulation

w. e. f. Academic Year:	AY 2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Transportation Engineering, Traffic Engineering
Rationale:	Increased vehicular ownership has created problems of congestion, pollution and accidents on urban road network acutely. Hence, it is necessary for the Traffic Engineer to understand behaviour of traffic flow, its characteristics, and theories developed to prepare its model and its quantification. These theories are also useful to develop the traffic simulation models. The actions for traffic control and measures for mitigating the impacts can be implemented effectively after studying the simulation of traffic conditions. Therefore, it is essential for the Traffic Engineer to know about the procedure of traffic simulation. This course includes various traffic flow theories and procedures for developing traffic simulation models.

Program Outcomes

No	Program Outcomes
01	Engage in critical thinking and research to develop solutions to multifold real-world problems.
02	Communicate effectively with the engineering community at large level on complex design tasks & write and present technical reports.
03	Demonstrate a high level of professionalism in handling multidisciplinary and complex traffic engineering problems.
04	Plan, assess, create, integrate, carry out, and oversee complex transportation infrastructure projects in a sustainable local and global context.
05	Address societal issues pertaining to transportation by offering technologically advanced, reasonably priced solutions while upholding high standards of ethics and professionalism.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Comprehend the traffic stream characteristics	U
02	Distinguish methods of traffic flow modelling.	N, A
03	Analyse shock waves and queuing patterns.	N, A
04	Develop and validate traffic simulation models.	N, A
05	Understand the concept of Highway Capacity and LoS	U

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**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Traffic Stream Characteristics:** Measurement, microscopic and macroscopic study of traffic stream characteristics -flow, speed and concentration; use of counting, interval and translated distributions for describing vehicle arrivals, headways, speeds, gaps and lags; fitting of distributions, goodness of fit tests, gap acceptance.	8	18
2	**Traffic Stream Models:** Fundamental equation of traffic flow, speed-flow-concentration relationships, normalised relationship, fluid flow analogy approach, shock wave theory, platoon diffusion and Boltzmann like behaviour of traffic flow, car-following theory, linear and non-linear car-following models, acceleration noise	12	27
3	**Queuing Analysis:** Fundamentals of queuing theory, demand service characteristics, deterministic queuing models, stochastic queuing models, multiple service channels, models of delay at intersections and pedestrian crossings.	8	18
4	**Highway Capacity & Level-of-Service Studies:** Concepts, factors affecting capacity & level-of service, capacity analysis of different highway facilities, passenger car units, problems in mixed traffic flow.	7	15
5	**Traffic Simulation:** Fundamentals and concepts, components of traffic simulation, mathematical simulation model development, macroscopic, microscopic, and mesoscopic simulation models, software for simulation, calibration and validation of simulation model, generation of random numbers, examples.	10	22
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
30	**20**	**30**	**10**	**10**	**--**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

(a) Reference Books:

1. TRB - SR No.165 - Traffic Flow Theory, Transportation Research Board, Washington - D.C.
2. May, A D., Traffic Flow Fundamentals, Prentice-Hall, NJ
3. Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York.
4. TRB Special Report 209: Highway Capacity Manual, Transportation Research Board, Washington DC, 1985.
5. Wohl M. and Martin, B V., Traffic System Analysis for Engineers and Planners, McGraw-Hill, New York.
6. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ, 1990.
7. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley.
8. Highway Capacity Manual, Transportation Research Board, Washington DC, 2000, 2010, 2016.
9. Indian Highway Capacity manual (Indo HCM 2017)
10. Roger P. Roess, E. S. Prassas and W. R. McShane, Traffic Engineering, Prentice Hall.
11. Boris S. Kerner, Introduction to Modern Traffic Flow Theory and Control, Springer, 2009, First Edition.
12. Fred L. Mannering, and Scott S. Washburn, Principles of Highway Engineering and Traffic Analysis, Jhon Wiley & Sons, 2013, Fifth Edition.
13. Gerlough DL and Huber MJ., Traffic Flow Theory: A Monograph, TRB special report 165, 1992.

(b) List of Open-Source Software (May not be open source but useful for the subject)

1. PTV VISSIM &VISUM- Traffic Simulation Software, Academic version for the students
2. SIDRA
3. Any Logic

(c) Online Resources:

1. https://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/technical manuals/modellingguidelines.pdf
2. https://www.cityservices.act.gov.au/__data/assets/pdf_file/0009/1539576/ACT-Traffic-

Microsimulation-Modelling-Guidelines.pdf

(d) List of Experiments:

1. Classified traffic volume count along with spot speed data on congested urban road mid-block section (Preferably using videography).
2. Generation of speed-flow-density relationship from the collected data.
3. Statistical analysis of the collected data for the parameters like - vehicle arrival pattern, headway, speed, gap, overtaking, queuing etc.
4. Intersection volume count and delay measurements.
5. Pedestrians flow measurement and their crossing behavior analysis.
6. Data collection for determining highway capacity and level of service.
7. Computer simulation of observed traffic data, using programme or software.
8. Simulation experiments for improving the traffic conditions.

(e) List of Tutorials/Assignments/ OEPs:

Below mentioned problems are for reference only. Similar problems may be developed by individual teachers.

1. Simulation of overtaking behavior on urban arterial
2. Simulation of effect on traffic stream by introducing bump/speed breaker
3. Simulation of pedestrian crossing - with and without pedestrian signals
4. Simulation of uncontrolled and signalized intersection
5. Simulation of pre-timed versus actuated signalized intersection

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