CE740 (3 0 0 6) - Traffic Engineering (2024)

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(PDF - for better view)

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1 Overview

1.1 Eligibility

- 1. This is a 6 credit core course for the First Year M. Tech (Transportation Systems Engineering) students
- 2. This course is running in Slot 5 and has two lectures per week
 - (a) Slot 5A Wed 09:30 10:55
 - (b) Slot 5B Fri 09:30 10:55
- 3. Only 60 students are allowed to register for this course
- 4. This course is also open to:

- (a) Final Year B. Tech Civil Engineering students
- (b) Completed TE-I (CE-310) and TE-II (CE-334)

Note: B. Tech students can tag it as a Department Elective if the Faculty Adviser approves

1.2 Course contents

Link to Download Lecture Plan

- 1. **Traffic stream characteristics**: Road user and vehicle characteristics, Fundamental parameters and relations, Traffic Stream Models, Modelling vehicle arrivals: Continuous distributions to model Headways and speed, Modelling vehicle arrivals: Discrete distributions to model flow and evaluation of distributions.
- Traffic measurement procedures: Measurement at a Point (Volume data collection and analysis, PCU, PHF etc.), Measurement over a Short Section (Speed data collection and analysis), Measurement along a Length of Road (Density and travel time measurement and analysis), Moving Observer Method, Traffic forecasting and growth studies.
- 3. **Microscopic traffic flow modelling**: Car Following Models: Linear models, Car Following Models: Non-linear models, Lane Changing Models, Microscopic Traffic Simulation (Vehicle generation, model frame work, calibration and validations, statistical error analysis, applications)
- 4. Macroscopic and mesoscopic models: Traffic Flow Modelling Analogies: First order models, analysis of shock waves, Traffic Flow Modelling Analogies: Numerical implementation and higher order models, Cell transmission models, Cellular automata models: Discrete Simulation, Traffic Progression and Platoon dispersion.
- 5. **Traffic Analysis and Management**: Capacity and Level of Service concepts, Queuing models and applications, Basics of traffic management.
- Traffic intersection control: Principles of Traffic Control and Traffic Signs, Road Markings and Channelization, Uncontrolled Intersection: Gap acceptance and capacity concepts, Uncontrolled Intersection: Capacity and LOS analysis, Traffic Rotaries and Grade Separated Intersection.
- Traffic signal design: Design Principles of Traffic Signal, Evaluation of a Traffic Signal: Delay Models, Capacity and LOS Analysis of a Signalized I/S, Coordinated Traffic Signal, Vehicle Actuated Signals and Area Traffic Control.

1.3 Evaluation

Туре	Marks	Remarks
Class participation	$\textbf{15.0}\pm5$	2-5 mts quizzes in class and attendance
Assignments (paper)	$\textbf{10.0}\pm5$	Handwritten
Assignments (digital)	$\textbf{15.0}\pm5$	Excel evaluation
Term paper	$\textbf{10.0}\pm5$	Presentation
Mid Sem	$\textbf{20.0} \pm 5$	Open self-hand written notes, no digital devices
End Sem	30.0 ± 5	Open self-hand written notes, no digital devices
Total	100	

1.4 Assignment Set I

Instructions: The dead line is Sep 20, 2024. Must be with you to write the midsem. This is paper based assignment. Keep one notebook exclusively for all the paper based assignments of this course. Write the questions and the answers to the questions and submit on time.

- 1. Exercise 1 from here
- 2. Exercise 2 from here
- 3. Exercise 4 from here
- 4. Exercise 5 from here
- 5. Exercise 7 from here
- 6. Exercise 6 from here
- 7. Exercise 12 from here
- 8. Exercise 13 from here
- 9. Exercise 3 from here
- 10. Exercise 5 from here
- 11. Exercise 7 from here
- 12. Exercise 2 from here
- 13. Exercise 1 from here
- 14. Exercise 5 from here

- 15. Exercise 2 from here
- 16. Exercise 3 from here
- 17. Exercise 7 from here
- 18. Exercise 2 from here
- 19. Exercise 9 from here
- 20. Exercise 2 from here

1.5 Assignment Set II

Instructions: This is an EXCEL based assignment. The dead line is Sep 20, 2024. Each question will be one file. Write the code using excel functions so that it will work for different data set also (i.e. do NOT use excel as a substitute for calculator). Using best use of excel functions and friendly layout will give better marks in evaluation. Do not share your excel files with class mates or take help from others. You are free to refer web resources on how to use excel. There will be an evaluation at the end of the semester.

 Verification of the relationship between time mean speed and space mean speed: Details: Column A contains lower limit of speed (vl) and column B contains upper limit of speed (vu), and and column C contains the frequency or flow (qi). Fill about ten rows with hypothetical data. Compute mean speeds, and standard deviation and then verify the relationship.

File name (follow STRICTLY): yourrollno-ce740-q01.xlsx Submision Link for Q1

- 2. Calibration of Greenshields model: (Part I). Column A contains 7 to 12 space mean speeds (vs), column B contains corresponding density (k). Calibrate Greenshields model, i.e find vf and kj. Using this compute flow values (q). (Part II). Plot using the previous data the relations showing (a) k-v, (b) q-k, (c) q-v. File name (follow STRICTLY): yourrollno-ce740-q02.xlsx Submision Link for Q2
- 3. Implement moving observer method in excel. User input includes mo, mp, ma, ta, tw, and I for at least 5-7 samples. Compute the results and plot the fundamental diagrams. File name (follow STRICTLY): yourrollno-ce740-q03.xlsx Submision Link for Q3
- 4. Implement a simple GM's car-following model same as the one that is solved in the class. However, it should work for at least 120 seconds and should work for different values of sensitivity coefficients and initial conditions. Show the graphical plot of how

the speed and acceleration of the follower changes with that of the leader. File name (follow STRICTLY): yourrollno-ce740-q04.xlsx Submision Link for Q4

- 5. Modeling Vehicle Arrival using headway: The excel sheet should take input in three columns and 7 to 15 rows. first column is the lower limit of the headway range, second column is the upper limit of the headway range, and third column is the frequency (no of observations in this range). (i) Compute the observed probabilities, and the probabilities using exponential, normal, and person type III distribution, in adjacent columns. (ii) Show these probabilities in a graph. (iii) The sheet should also contain cells which show the mean, standard deviation, and chi-square values of the observed and computed headway. Note: you can have several columns for intermediate calculations. File name (follow STRICTLY): yourrollno-ce740-q05.xlsx Submision Link for Q5
- Generating Headway Following Exponential Distribution. Input: the flow rate in vehicles per hour. Generate about one to ten thousand headway. Show the probabilities of the generated headway and the expected headway in a graphical form.
 File name (follow STRICTLY): yourrollno-ce740-q06.xlsx Submision Link for Q6

1.6 Assignment Set III (Deadline: 2024 Nov 10)

Instructions: This is a PAPER based assignment. Note: All these questions are geometric related. Hence, full marks will be given only if the sketches/diagrams are neat and proper.

- 1. Give four examples of 'no control' (refer basic driving rules in India from internet) Give the source from where it is taken.
- Give two examples (with colored sketch) for each of the following categories of traffic signs: (i) Right of way series, (ii) Movement series, (iii) Informative signs, and (iv) Warning signs
- 3. A road has four lanes; two lanes on each direction. A bridge goes over the road, which has a pillar at the middle of road. Illustrate with neat sketch the road markings that are to be provided.
- 4. Illustrate with a neat sketch a typical channelization plan for a three legged urban intersection having very high volume traffic. Show also the complementing traffic signs and road marking to be provided for this intersection.
- 5. Exercise 2 from here
- 6. Draw a neat sketch of a diamond interchange and mark all the traffic movements. Discuss the situations where this is warranted.

- Draw a neat sketch of a fully clover leaf intersection and mark all the traffic movements. Discuss the situations where this is warranted.
- 8. Consider a four legged signalized intersection having only through movements. The signal has two phases, the first phase has only east-west movements and the second phase has only north-south movements. The lost time is denoted as t_{L_1} and t_{L_2} and the yellow time as Y_1 and Y_2 for the first and second phases respectively, and the cycle length is denoted as C. All times are in seconds. Traffic volumes in the north, east, west, and south directions in vehicle per hour are denoted as q_N , q_E , q_W , and q_S . Find the actual green time G_1 and G_2 that needs to be allocated for the first and second phases. Given that: t_{L_1} =2.60, t_{L_2} =2.60, Y_1 =4.00, Y_2 =3.00, q_N =360.0, q_E =310.0, q_W =360.0, q_S =360.0, and C=110.0.
- 9. An approach of a signalized intersection has three lanes. The vehicles queued at one of the lane crossed the stop line at t_1 , t_2 , t_3 , t_4 , t_5 , t_6 , and t_7 second after the green start. If we assume same behaviour for all the lanes, what will be maximum number of vehicles that can cross through this approach if there is infinite queue and continuous green? Given that: t_1 =3.70, t_2 =7.20, t_3 =10.30, t_4 =13.10, t_5 =15.30, t_6 =17.50, and t_7 =19.70.
- 10. If the north, east, west, and sound bound traffic in a junction are 1600, 1900, 1800, and 1700 respectively, what geometry will you suggest to be operated under a signal control? Assume two phase signal with no turning traffic and 2.2 second saturation headway.
- 11. For a signalized approach: if the cycle length is 48 sec, green time is 24 sec, yellow time is 3 sec, saturation headway is 2 sec, lost time is 5 sec, vehicle arrival rate is 900 vph: (A) what is the capacity of the movement, and (B) what will be the stopped delay for a 15 minutes interval?
- 12. Find the capacity and average delay caused for minor road vehicles for an uncontrolled intersection with major and minor road flows are 900 vph and 252 vph respectively. The minimum time headways between major and minor road vehicles are 1 sec and 3 sec respectively and the average gap or lag accepted by the minor stream is 4 sec.
- 13. Find the critical gap using Ralph's method given the following data (where *t* is the time, g_a is the number of accepted gap less than *t*, and g_r is the no of rejected gap greater than *t*:

g_a	g_r
0	146
0	138
1	128
3	113
8	85
21	55
38	27
52	18
68	12
81	8
98	5
115	2
138	0
	 g_a 0 1 3 8 21 38 52 68 81 98 115 138

1.7 Assignment Set IV (Deadline: 2024 Nov 10)

Instructions: This is an EXCEL based assignment corresponding to Module VII. Write the code using excel functions so that it will work for different data set also (i.e. do use excel as a substitute for calculator). Using best use of excel functions and friendly layout will give better marks in evaluation. Do not share your excel files with class mated or take help from others. You are free to refer web resources.

1. Traffic signal design: For a given intersection having four approaches and each approach having three lanes each, find the cycle length, green time and the resulting intersection delay. Three problems for the above intersection, which differs in phase plan needs to be solved. The first three sheet is for problems 1, 2, and 3 respectively and the fourth sheet is a summary sheet which has the input and output. First three sheet should take the input from the summary sheet. Similarly, the summary sheet should take output from the above sheets. The problem details are given in a pdf file and can be downloaded from here

2 Term Paper

2.1 General

1. Term Paper Folder:

- 2. Select three papers of your choice. Consider the following while selecting the paper:
 - (a) You will present only one paper
 - (b) You are not required to understand everything in the paper, but
 - (c) Identify the innovation achieved or new idea proposed in the paper
 - (d) Present the concept methodology and major results from the paper
- 3. Google Form: Submit your first, second, and third choice in the form.
- 4. Further clarifications and instructions will be given in the class.

2.2 Instructions for preparing the presentation

- 1. You have to prepare a power point presentation STRICTLY as per the following template. It should have minimum 5 slides and maximum 7 slides.
 - (a) Slide 1. Title, author, journal, and below your name and roll no
 - (b) Slide 2. Aim or objectives of the research (what is attempted in the paper) and the need for this research study.
 - (c) Slides 3-4. (Max 2 slides) Major aspects of the methodology adopted in the study (preferably with figures, flow chart etc.)
 - (d) Slides 5-6. (Max 2 slides) Key results or findings from the study (preferably with figures, graphs, tables, etc.)
 - (e) Slide 7. Contribution (the innovation or new thing the authors claim to have achieved in the paper). In other words, what are the reasons for publishing this paper in this journal?

2.3 Instructions for giving the presentation

A three minute video.

3 Resources (Audio/Video/PDF) from past lectures

0. L00-2021-07-26 General Introduction Video 300 MB and Audio 45 MB (48 mts)

- L01-2021-07-29 Fundamental Parameters of Traffic Flow Video 121 MB and Audio 42 MB (44 mts) Lecture note is here
- L02-2021-07-29 Fundamental Relations of Traffic Flow Video 61 MB and Audio 24 MB (26 mts) Lecture note is here
- L03-2021-08-02 Traffic Stream Models Part I Video 106 MB and Audio 34 MB (36 mts) Lecture note is here
- L04-2021-08-02 Traffic Stream Models Part II Video 156 MB and Audio 46 MB (49 mts) Lecture note is same as above.
- L05-2021-08-05 Traffic Stream Models Part III
 Video 92 MB and Audio 29 MB (30 mts)
 Lecture note is same as above.
- L06-2021-08-05 Modeling Vehicle Arrival Part I Video 73 MB and Audio 19 MB (21 mts) Lecture note is here
- L07-2021-08-09 Modeling Vehicle Arrival Part II
 Video 156 MB and Audio 40 MB (42 mts)
 Lecture note is same as above.
- L08-2021-08-09 Modeling Vehicle Arrival Part III
 Video 56 MB and Audio 17 MB (18 mts)
 Lecture note is same as above.

- L09-2021-08-12 Modeling Vehicle Arrival Part IV
 Video 143 MB and Audio 35 MB (38 mts)
 Lecture note is same as above.
- L10-2021-08-12 Modeling Vehicle Arrival Part V
 Video 89 MB and Audio 29 MB (31 mts)
 Lecture note is same as above.
- L11-2021-08-16 Modeling Vehicle Arrival Part VI
 Video 64 MB and Audio 30 MB (32 mts)
 Lecture note is here
- 12. L12-2021-08-16 Modeling Vehicle Arrival Part VII
 Video 70 MB and Audio 26 MB (28 mts)
 Lecture note is same as above.
- L13-2021-08-23 Modeling Vehicle Arrival Part VIII
 Video 177 MB and Audio 48 MB (51 mts)
 Lecture note is same as above.
- 14. L14-2021-08-26 Modeling Vehicle Arrival Part IX
 Video 152 MB and Audio 40 MB (44 mts)
 Lecture note is same as above.
- 15. L15-2021-08-26 Traffic Measurements: Measurements at a point I
 Video 46 MB and Audio 17 MB (18 mts)
 Lecture note is here Class note is here
- 16. L16-2021-08-30 Traffic Measurements: Measurements at a point II
 Video 66 MB and Audio 26 MB (27 mts)
 Lecture note same as above Class note is same as above

- 17. L17-2021-08-30 Traffic Measurements: Measurements at a short section
 Video 48 MB and Audio 22 MB (23 mts)
 Lecture note is here Class note is here
- L18-2021-09-02 Traffic Measurements: Measurements along the length of a road Video 127 MB and Audio 39 MB (42 mts) Lecture note is here Class note is here
- L19-2021-09-02 Traffic Measurements: Moving Observer Method Video 90 MB and Audio 30 MB (32 mts) Lecture note is here
- 20. L20-2021-09-06 Car Following Models I Video 90 MB and Audio 36 MB (39 mts) Lecture note is here
- 21. L21-2021-09-06 Car Following Models II Video 90 MB and Audio 34 MB (36 mts) Lecture note is same as above
- 22. L22-2021-09-09 Lane Changing Models I and Simulation
 Video 147 MB and Audio 36 MB (38 mts)
 Lecture notes are here and here
- 23. L23-2021-09-06 Lane Changing Models II
 Video 278 MB and Audio 55 MB (59 mts)
 Lecture note is same as above
- 24. L24-2021-09-20 Intersection Control I
 Video 119 MB and Audio 36 MB (38 mts)
 Lecture note is here Presentation in pdf here

- 25. L25-2021-09-20 Intersection Control II
 Video 123 MB and Audio 30 MB (32 mts)
 Lecture note is same as above
- 26. L26-2021-09-23 Traffic Signs
 Video 129 MB and Audio 43 MB (46 mts)
 Lecture note is here Presentation in pdf here
- 27. L27-2021-09-23 Road Markings
 Video 69 MB and Audio 22 MB (23 mts)
 Lecture note is here Presentation in pdf here
- 28. L28-2021-09-27 Channelization
 Video 109 MB and Audio 50 MB (53 mts)
 Lecturenote is here Presentation in pdf is here
- 29. L29-2021-09-30 Traffic Rotaries
 Video 135 MB and Audio 43 MB (46 mts)
 Lecture note is here
- 30. L30-2021-09-30 Traffic Signal Design I
 Video 61 MB and Audio 21 MB (22 mts)
 Lecture note is here

Traffic signal design lectures of 2020 Part A (95 MB, 45 mts) Part B (127 MB, 52 mts) Part C (120 MB, 50 mts) Part D (106 MB, first 27 out of 52 mts)

L31-2021-10-04 Traffic Signal Design - II
 Video 121 MB and Audio 35 MB (38 mts)

Lecture notes are same as above

- 32. L32-2021-10-04 Traffic Signal Design III
 Video 121 MB and Audio 31 MB (32 mts)
 Lecture notes are same as above
- 33. L33-2021-10-07 Traffic Signal Design IV
 Video 158 MB and Audio 38 MB (41 mts)
 Lecture notes are same as above
- 34. L34-2021-10-07 Traffic Signal Design V
 Video 104 MB and Audio 27 MB (29 mts)
 Lecture notes are same as above
- 35. L35-2021-10-11 Delay Models I
 Video 109 MB and Audio 34 MB (37 mts)
 Lecture notes are available here
- 36. L36-2021-10-11 Delay Models I
 Video 123 MB and Audio 32 MB (35 mts)
 Lecture notes are available here
- 37. L37-2021-10-14 Coordinated Signals I
 Video 162 MB and Audio 41 MB (44 mts)
 Lecture notes are available here
- 38. L38-2021-10-14 Coordinated Signals II
 Video 93 MB and Audio 23 MB (24 mts)
 Lecture notes are available here
- 39. L39-2021-10-18 Vehicle Actuated Signals Video 112 MB and Audio 37 MB (40 mts)

Lecture notes are available here

- 40. L40-2021-10-18 Area Traffic Control Video 84 MB and Audio 29 MB (31 mts) Lecture notes are available here
- 41. L41-2021-10-21 Capacity and Level of Service I
 Video 115 MB and Audio 40 MB (43 mts)
 Lecture notes are available here
- 42. L42-2021-10-21 Capacity and Level of Service II
 Video 89 MB and Audio 23 MB (24 mts)
 Lecture notes are available here
- 43. L43-2021-10-25 Macroscopic Traffic Flow Modeling I
 Video 170 MB and Audio 47 MB (51 mts)
 Lecture notes are available here
- 44. L44-2021-10-25 Macroscopic Traffic Flow Modeling II
 Video 73 MB and Audio 18 MB (19 mts)
 Lecture notes are available here
- 45. L45-2021-10-28 Macroscopic Traffic Flow Modeling III
 Video 158 MB and Audio 39 MB (42 mts)
 Lecture notes are available here
- 46. L46-2021-10-28 Macroscopic Traffic Flow Modeling IV
 Video 186 MB and Audio 21 MB (22 mts)
 Lecture notes are available here

References

- D R Drew. *Traffic flow theory and control*. McGraw-Hill Book Company, New York, 1968.
 IITB–.
- [2] Highway Capacity Manual. *Transportation Research Board*. National Research Council, Washington, D.C., 2000.
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- [4] S K Khanna and C E G Justo. *Highway Engineering*. Nemchand Bros.,, Roorkee, 1991.
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