

CE740 (3 0 0 6) - Traffic Engineering (2023)

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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.
2. **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.
6. **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.
7. **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

Type	Marks	Remarks
Quizzes	15.0 ± 5	2-5 mts in class
Assignments I	10.0 ± 5	Handwritten
Assignments II	10.0 ± 5	Excel
Term paper	15.0 ± 5	Presentation
Mid Sem	20.0 ± 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 **Aug 31, 2023** 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 3 from [here](#)
4. Exercise 3 from [here](#)
5. Exercise 5 from [here](#)
6. Exercise 3 from [here](#)
7. Exercise 6 from [here](#)
8. Exercise 7 from [here](#)
9. Exercise 8 from [here](#)
10. Exercise 2 from [here](#)
11. Exercise 3 from [here](#)
12. Exercise 4 from [here](#)
13. Exercise 2 from [here](#)
14. Exercise 2 from [here](#)
15. Exercise 4 from [here](#)
16. Exercise 2 from [here](#)

1.5 Assignment Set II

Instructions: This is an EXCEL based assignment. The dead line is **Sep ??, 2023** Each question will be one sheet. 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 mates or take help from others. You are free to refer web resources.

1. Verification of the relationship between time mean speed and space mean speed: Details: Column A contains lower limit of speed (v_l) and column B contains upper limit of speed (v_u), and column C contains the frequency or flow (q_i). Fill about ten rows with hypothetical data. Compute mean speeds, and standard deviation and then verify the relationship. File name: yourrollno-ce740-q01.xlsx
2. Calibration of Greenshields model: (Part I). Column A contains 7 to 12 space mean speeds (v_s), column B contains corresponding density (k). Calibrate Greenshields model, i.e find v_f and k_j . 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: yourrollno-ce740-q02.xlsx
3. Implement moving observer method in excel. User input includes m_o , m_p , m_a , t_a , t_w , and l for at least 5-7 samples. Compute the results and plot the fundamental diagrams. File name: yourrollno-ce740-q03.xlsx
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: yourrollno-ce740-q04.xlsx
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: yourrollno-ce740-q05.xlsx

6. 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: yourrollno-ce740-q06.xlsx

1.6 Assignment Set III

Instructions: This is a PAPER based assignment. This is **Optional**

1. Exercise 7 from [here](#)
2. Exercise 1 from [here](#)
3. Exercise 3 from [here](#)
4. Exercise 2 from [here](#)
5. The on and off time (in sec) of a presence type detector are given below. Assume that the duration of observation is 60 sec, the detector spacing is 4.1 m, and the vehicle length is 4.8 m. Calculate the flow in vehicles per hour, occupancy in percentage, density in veh/km, and time mean speed and space mean in km/hr.

On Time	Off Time
5.6	6.4
12.1	12.8
22.1	23.1
37.5	38.1
44.9	45.8

1.7 Assignment Set IV

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.
2. 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.
7. Draw a neat sketch of a fully clover leaf intersection and mark all the traffic movements. Discuss the situations where this is warranted.
8. Deadline: **Nov 21**

1.8 Assignment Set V

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.
2. The problem details are given in a pdf file and can be downloaded from [here](#)
3. Deadline: **2023 Nov 18**

1.9 Assignment Set VI

Instructions: This is an paper based assignment.

1. 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_{L1} and t_{L2} 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: $t_{L1}=2.60$, $t_{L2}=2.60$, $Y_1=4.00$, $Y_2=3.00$, $q_N=360.0$, $q_E=310.0$, $q_W=360.0$, $q_S=360.0$, and $C=110.0$.
2. 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 $t_7=19.70$.
3. 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.
4. 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?
5. Deadline: **Nov 21**

1.10 Assignment Set VII

Instructions:

1. This is a paper based assignment based on HCM 2000 Chapter 16 Example Problem 1.
2. The problem you have to solve is the 'example problem 1' given in the page 16-38 of HCM 2000.
3. The [HCM 2000 Ch. 16 download link](#) is here.

4. You have to solve the problem showing detailed calculation for **each of the four approaches**.
5. In addition, the results has to be tabulated in the following work-sheets from HCM-2000.
 - (a) Exhibit 16-20. Input worksheet
 - (b) Exhibit 16-21. Volume adjustment and saturation flow rate worksheet
 - (c) Exhibit 16-22. Capacity and LOS worksheet
 - (d) Supplemental worksheets not required.
6. You have to bring empty work sheets for the end-sem
7. Deadline: **Nov 21**

2 Resources (Audio/Video/PDF) from 2021

0. L00-2021-07-26 General Introduction
Video 300 MB and Audio 45 MB (48 mts)
1. L01-2021-07-29 Fundamental Parameters of Traffic Flow
Video 121 MB and Audio 42 MB (44 mts)
Lecture note is [here](#)
2. L02-2021-07-29 Fundamental Relations of Traffic Flow
Video 61 MB and Audio 24 MB (26 mts)
Lecture note is [here](#)
3. L03-2021-08-02 Traffic Stream Models Part I
Video 106 MB and Audio 34 MB (36 mts)
Lecture note is [here](#)
4. L04-2021-08-02 Traffic Stream Models Part II
Video 156 MB and Audio 46 MB (49 mts)
Lecture note is same as above.

5. L05-2021-08-05 Traffic Stream Models Part III
Video 92 MB and Audio 29 MB (30 mts)
Lecture note is same as above.
6. L06-2021-08-05 Modeling Vehicle Arrival Part I
Video 73 MB and Audio 19 MB (21 mts)
Lecture note is [here](#)
7. L07-2021-08-09 Modeling Vehicle Arrival Part II
Video 156 MB and Audio 40 MB (42 mts)
Lecture note is same as above.
8. L08-2021-08-09 Modeling Vehicle Arrival Part III
Video 56 MB and Audio 17 MB (18 mts)
Lecture note is same as above.
9. L09-2021-08-12 Modeling Vehicle Arrival Part IV
Video 143 MB and Audio 35 MB (38 mts)
Lecture note is same as above.
10. L10-2021-08-12 Modeling Vehicle Arrival Part V
Video 89 MB and Audio 29 MB (31 mts)
Lecture note is same as above.
11. 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.

13. 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](#)
18. 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](#)
19. 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)
31. 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

- [1] 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.
- [3] L. R Kadiyali. *Traffic Engineering and Transportation Planning*. Khanna Publishers, New Delhi, 1987.
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- [5] M L Manheim. *Fundamentals of transportation systems analysis Vol.1*. MIT Press, 1978.
- [6] Adolf D. May. *Fundamentals of Traffic Flow*. Prentice - Hall, Inc. Englewood Cliff New Jersey 07632, second edition, 1990.
- [7] William R McShane, Roger P Roesss, and Elena S Prassas. *Traffic Engineering*. Prentice-Hall, Inc, Upper Saddle River, New Jesery, 1998.
- [8] C. S Papacostas. *Fundamentals of Transportation Engineering*. Prentice-Hall, New Delhi, 1987.

[9] M Whol and B V Martin. *Traffic system analysis for engineers and planners*. McGraw Hill, Inc., 1983.