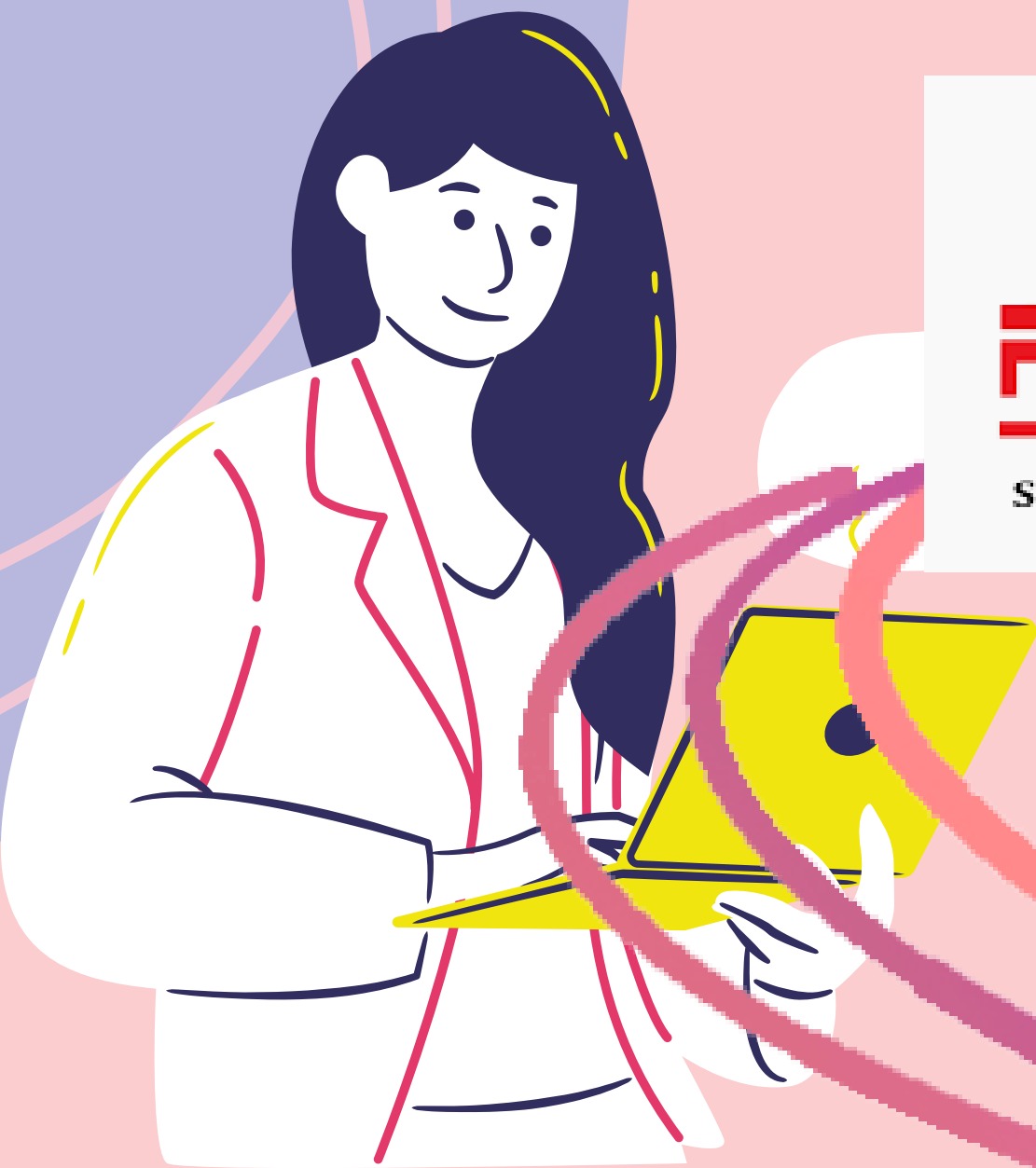
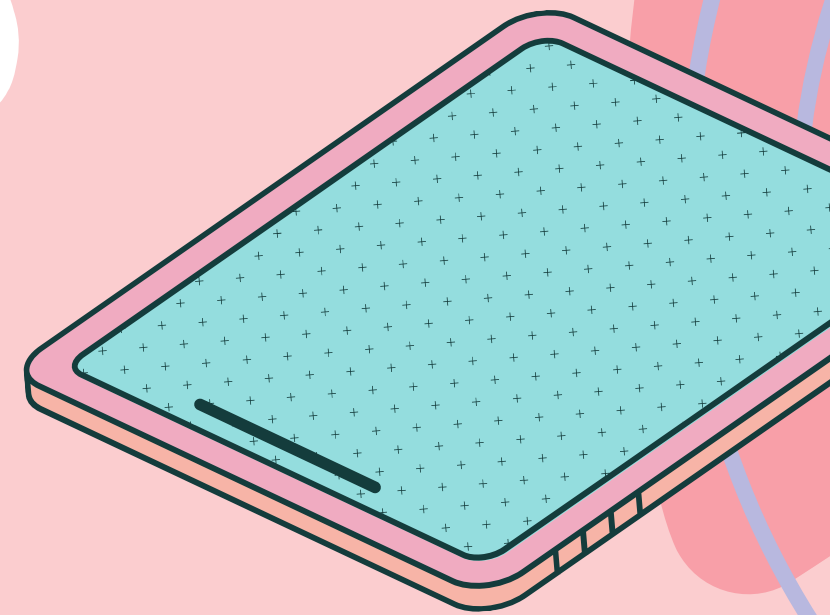




POLITEKNIK
MALAYSIA
SULTAN SALAHUDDIN ABDUL AZIZ SHAH



SMAHiTRA

(Smart application highway and traffic)

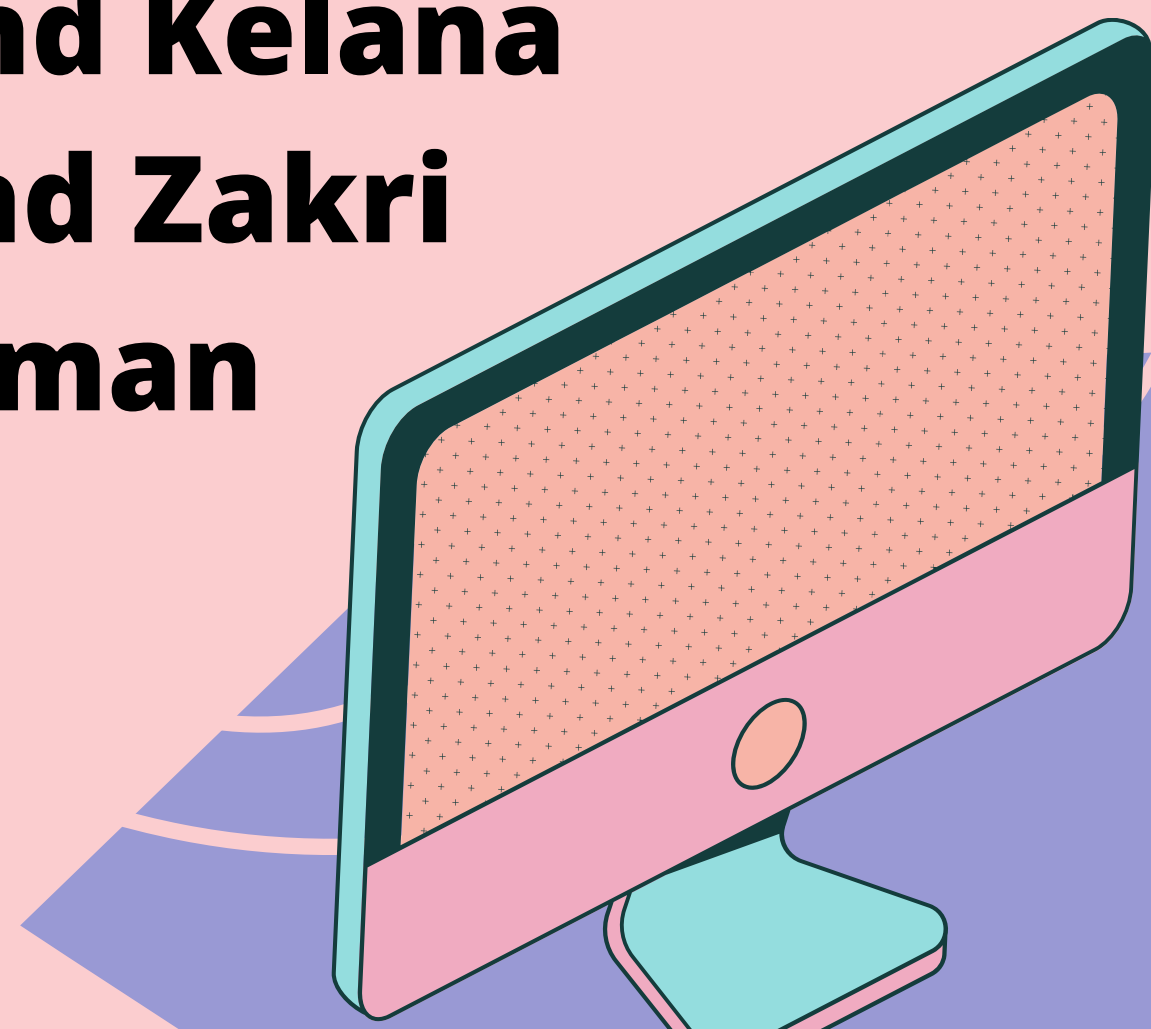


S P E C I A L P R O J E C T B Y

Muhammad Muzani Muhd Kelana

Nurul Ain Nabilah Mohd Zakri

Ainul Haezah Noruzman



SMAHiTRA

(Smart application highway and traffic)

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PREFACE

Assalamualikum w.b.t and greeting to all

It gives us a great pleasure to release the first edition of this book as a main reference for student who are enroll in Diploma of Civil Engineering program especially in subject of highway and traffic DCC30103.

The book is compulsory to use when using the SMHiTRA application especially for third semester students. The books contains method to install software that will be used to develop SMAHiTRA applications and how to use the SMAHiTRA application

Happy learning and good luck !



Muhammad Muzani Muhd Kelana
Nurul Ain Nabilah Mohd Zakri
Ainul Haezah Noruzman

Department of Civil Engineering
Polytechnic of Sultan Salahuddin Abdul Aziz Shah

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COURSE OUTLINE

PROGRAMME		DIPLOMA IN CIVIL ENGINEERING							
DEPARTMENT		CIVIL ENGINEERING							
COURSE		HIGHWAY AND TRAFFIC ENGINEERING							
COURSE CODE		DCC30103							
SLT & CREDIT		120 & 3							
PRE-REQUISITE		NONE							
SYNOPSIS									
HIGHWAY AND TRAFFIC ENGINEERING is a study on history of highway construction and the organization involved in Malaysia. This course also provides the students with the knowledge regarding the method and design involved in traffic engineering. This course emphasizes on introduction to highway and traffic, pavement materials, construction of flexible pavement, construction of rigid pavement, traffic control equipment and road furniture, flexible pavement design, junction design, traffic management and highway maintenance.									
COURSE LEARNING OUTCOME (CLO)									
CLO	PLO	DT	CLO DESCRIPTION						
1	PLO 1	C3	Apply appropriate model to solve problem in highway and traffic engineering						
2	PLO 3	C5	Assesses design performance for highway and traffic engineering based on appropriate specification with consideration of public safety, society and environment						
3	PLO 10	A3	Explain the findings of a case study in a formal presentation						
TOPICS & ASSESSMENTS									
NO.	TOPICS	CLO	ONLINE TnL METHOD(S)		CONTINUOUS ASSESSMENT (100%)				FINAL EXAM (F2F)
			SYN	ASYN	TEST (Online)	ASSIGNMENT (Online)	CASE STUDY (Online)	PRESENTATION (Online)	
					20% (2)	10% (1)	15% (1)	5% (1)	
1	INTRODUCTION TO HIGHWAY AND TRAFFIC	1	✓	✓	✓				✓
2	PAVEMENT MATERIALS	1,3	✓	✓	✓				✓
3	CONSTRUCTION OF FLEXIBLE PAVEMENT	1	✓	✓	✓				✓
4	CONSTRUCTION OF RIGID PAVEMENT	1	✓	✓	✓				✓
5	FLEXIBLE PAVEMENT DESIGN	1,2	✓	✓	✓				✓
6	TRAFFIC CONTROL EQUIPMENT ,ROAD FURNITURE AND ROAD MARKING	1	✓	✓	✓				✓
7	JUNCTION DESIGN	1,2,3	✓	✓	✓	✓			✓
8	TRAFFIC MANAGEMENT	1,2,3	✓	✓	✓	✓	✓		✓
9	HIGHWAY MAINTENANCE	1,2,3	✓	✓	✓		✓	✓	✓

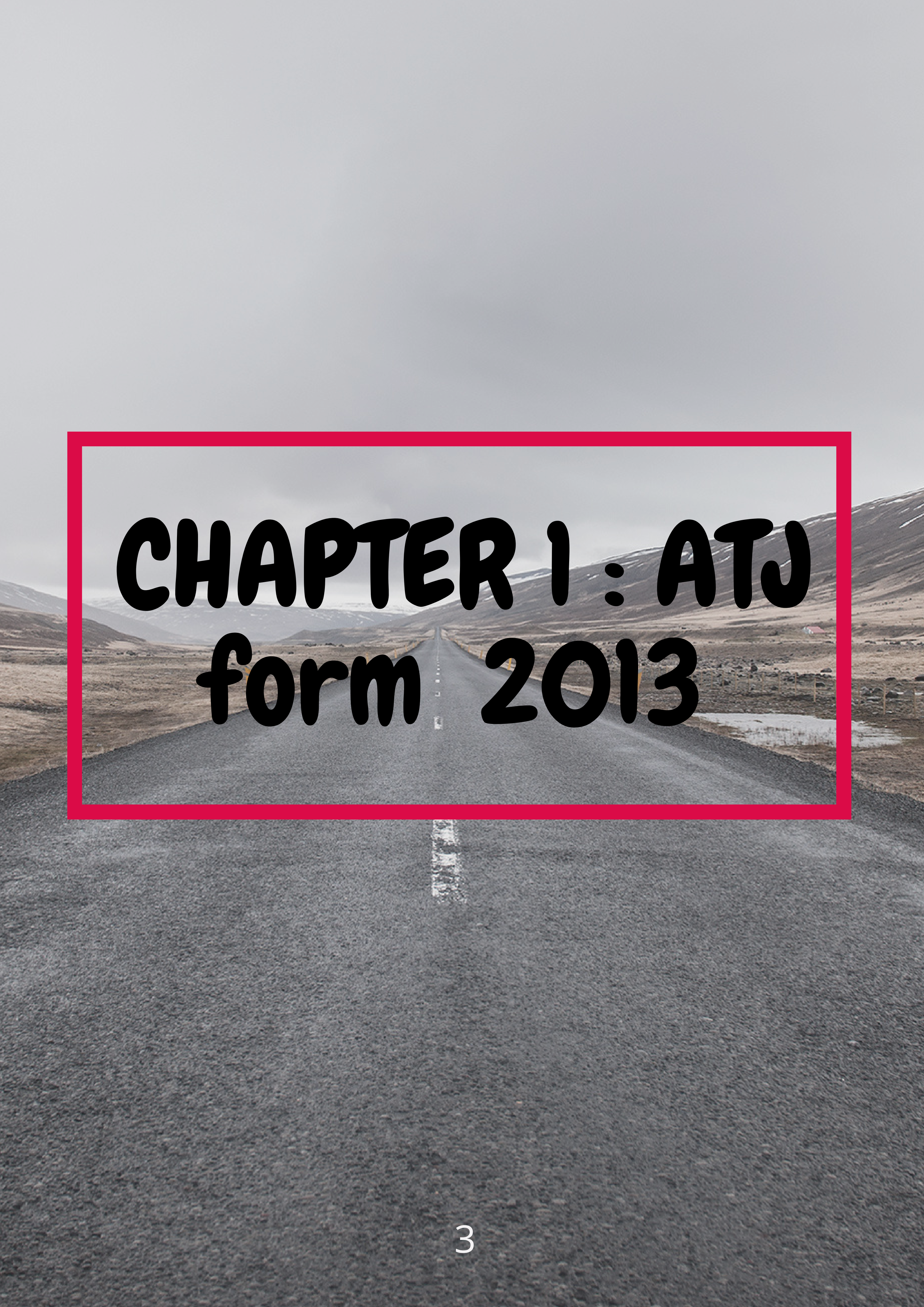
REFERENCES	
1	Arahan Teknik Jalan (Jalan) 8/86.(Pindaan 2015). <i>A Guide On Geometric Design Of Roads</i> .Cawangan Ibu Pejabat JKR.
2	Arahan Teknik Jalan (Jalan) 5/85. (Pindaan 2013). <i>Manual For The structural Design of Flexible Pavement Design</i> .
3	Arahan Teknik Jalan (Jalan) 11/87. <i>A Guide To The Design Of At Grade Intersection</i> Cawangan Jalan Ibu Pejabat JKR Kuala Lumpur
4	Martin,R (2009). <i>Highway Engineering</i> . 111 River Street Hoboken, NJ: Wiley, John & Sons, Incorporated
5	Atkins,H.N.(2003) <i>Highway Materials,Soils and Concrete</i> . Saddle River, New Jersey Prentice Hall
6	Banks,J.H.(2002).Introductionto Transportation Engineering (2nd ed.). New York: McGraw Hill.
7	Bent,T.(2005). <i>Highway and Traffic Engineering in Developing Countries</i> . UK: Spon Press
8	O'flaherty. (2008). <i>Transport Planning and Traffic Engineering</i> :U.S.A Butterworth-Heinemann

Note:

DT – DOMAIN TAXONOMY (AS STATED IN SYLLABUS)

SYN – SYNCHRONOUS (LIVE TEACHING: MS TEAMS)

ASYN – ASYNCHRONOUS (DIGITAL INSTRUCTIONAL MATERIAL: LMS CIDOS)



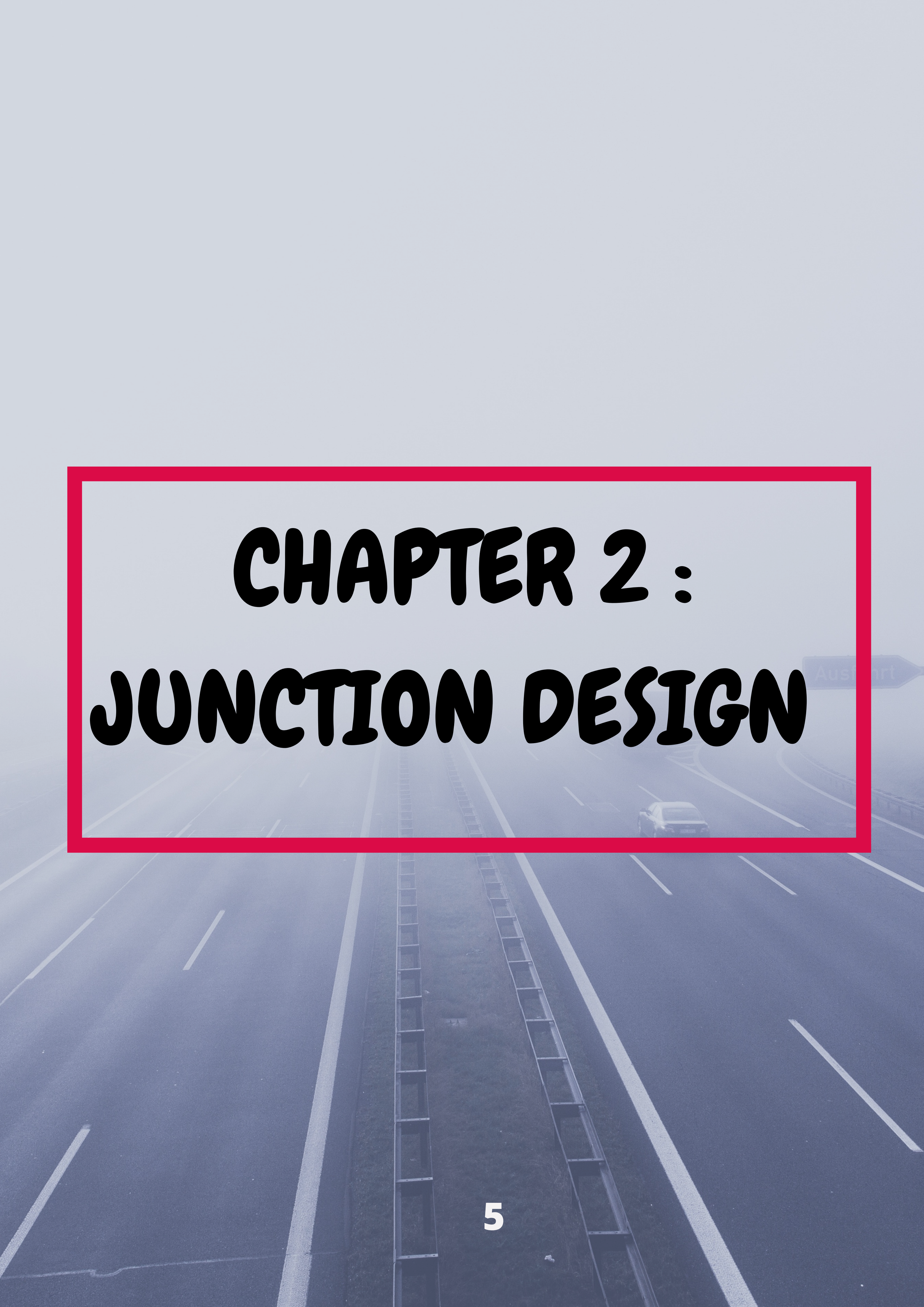
CHAPTER 1 : ATJ form 2013

INTRODUCTION OF ATJ FORM 2013

This manual on the design of flexible pavement structures aims to provide JKR and consultants engaged in pavement engineering projects in Malaysia with a uniform process of designing pavement for all classes of traffic. This manual is based on proven validated pavement design technologies; it builds on past JKR practice and experience and on design methodologies that have been successfully used in other countries over the last twenty years.

The design approach recommended in this manual combines improved design development data and mechanistic method of analysis into a single tool that is presented in the form of a catalog of pre-designed pavement structures.





CHAPTER 2 : JUNCTION DESIGN

INTRODUCTION OF JUNCTION DESIGN

A road junction is a location where vehicular traffic going in different directions can proceed in a controlled manner designed to minimize accidents. In some cases, vehicles can change between different routes or directions of travel. An intersection is a road junction where two or more roads either meet or cross at grade (they are at the same level).

Such a road junction may also be called a crossroads. At grade intersections present a driver with several points of conflict with other vehicles. The aims of intersection design are to improve traffic flow and reduce the number of accidents.





SMAHITRA

SMAHITRA



3.1 INTRODUCTION OF SMAHiTRA

SMAHiTRA application is an application used in highway and traffic subjects registered under DCC 30103. This subject is registered in semester 3 as a civil engineering major subject. This app is a device that helps students perform the calculations found in this subject. The calculation topics involved are topic 5 and topic 7, namely the 2013 ATJ form and Junction Design.

The function of SMAHiTRA was created to help students make calculations more quickly and accurately. Therefore students can save time and make it easier for students to understand the sub-topics taught. In addition, these apps also display notes that will help students in the calculations to be done. Accordingly, students do not need to open books or notes to make references

Title :Smart application highway and traffic (SMAHiTRA)

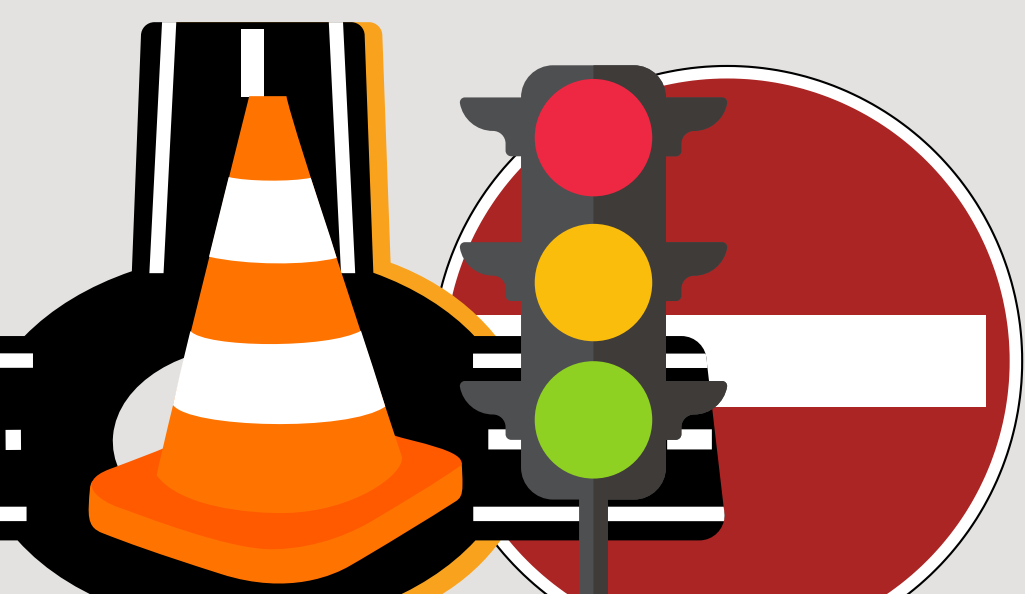
Aim : The goal of creating this SMAHiTRA application is to help student learn more effectively.

Objective of smahitra apps:

- 1) To produce smart application (SMAHiTRA) for students effective learning
- 2) To evaluate student performance using smart application (SMAHiTRA)
- 3) To determine the statisfaction among student using smart application (SMAHiTRA)

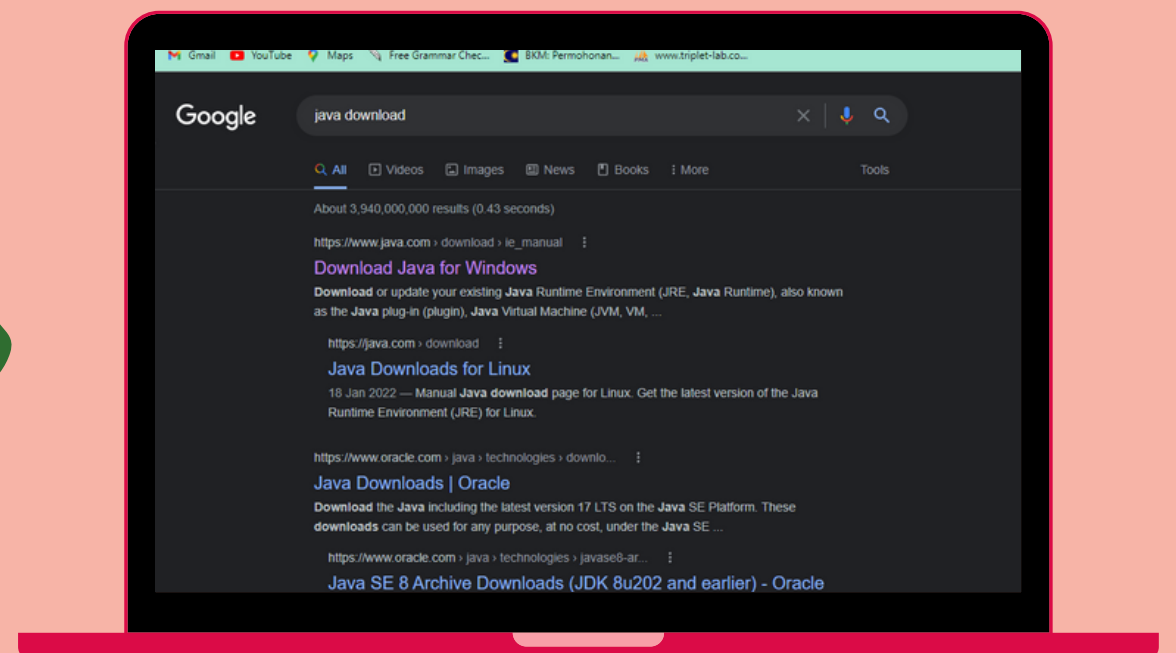
Advantages of smahitra:

- 1) Helping students can easily understand how the calculation are done
- 2) Helping students to speed up the calculation process
- 3) The application is simple to use and quick to load.

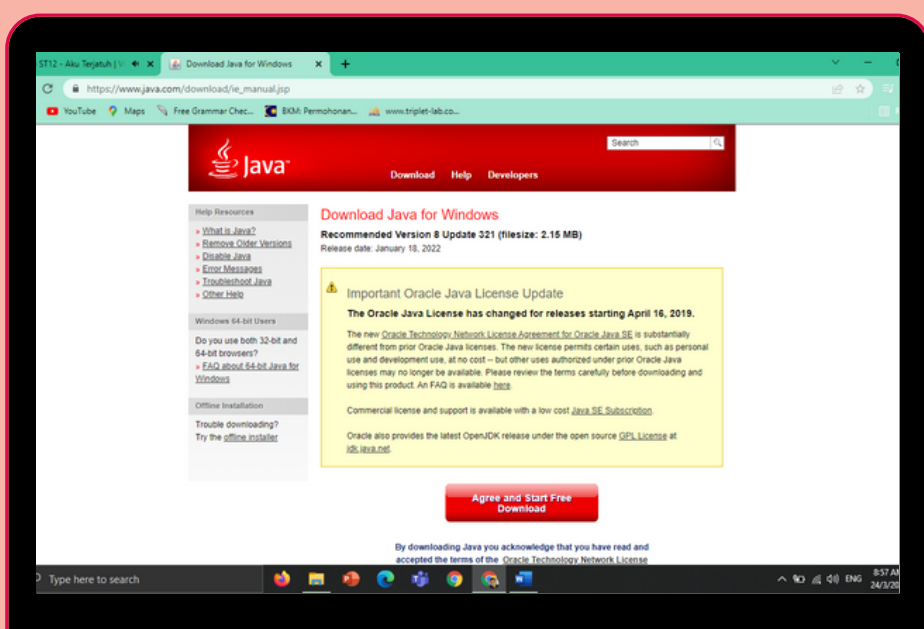


3.2 METHOD TO INSTALL SOFTWARE TO DEVELOP SMAHITRA APPLICATION

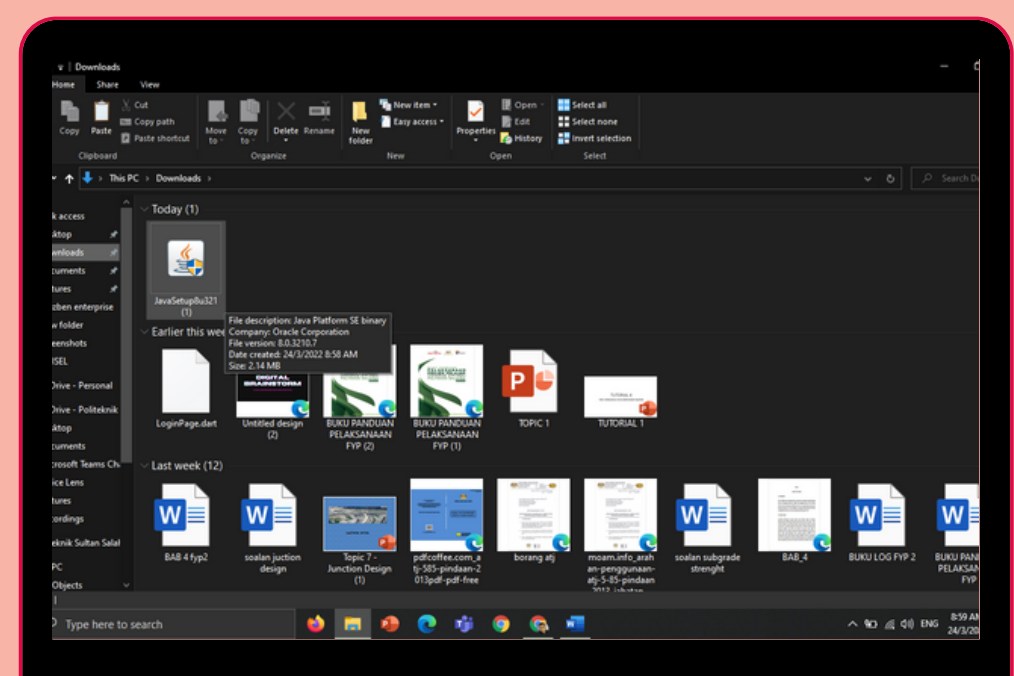
1. First download the java script
2. Open the google and search for JAVA DOWNLOAD



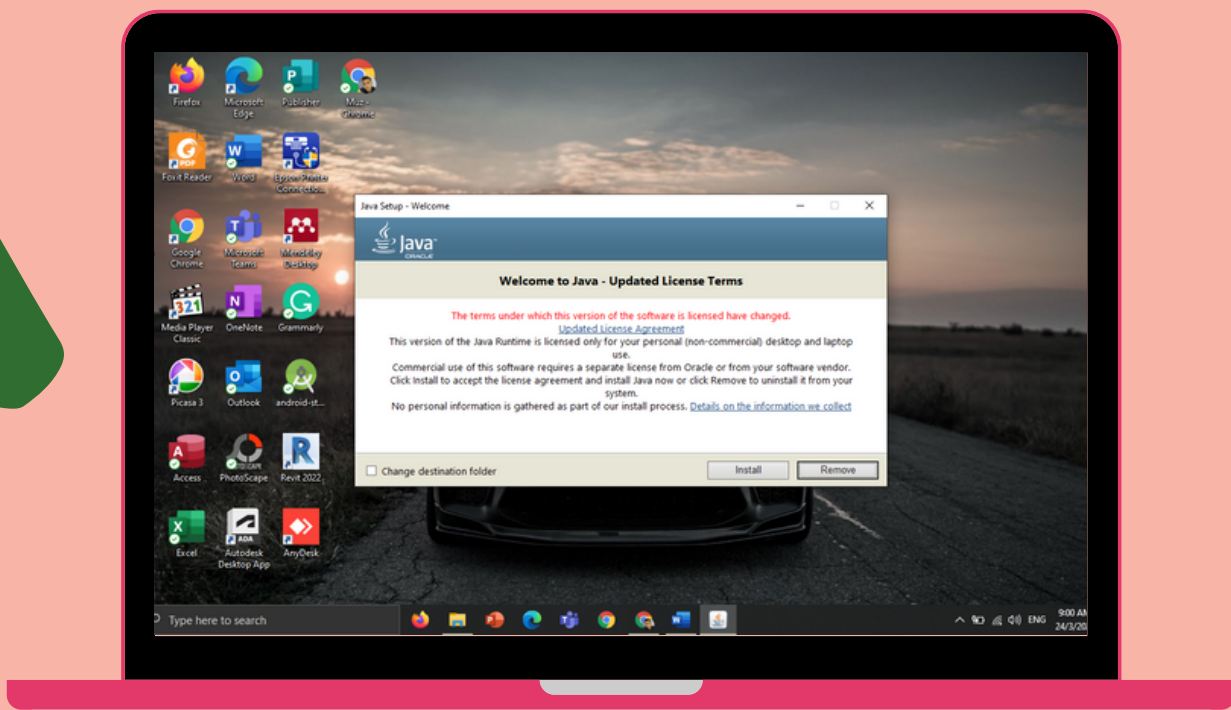
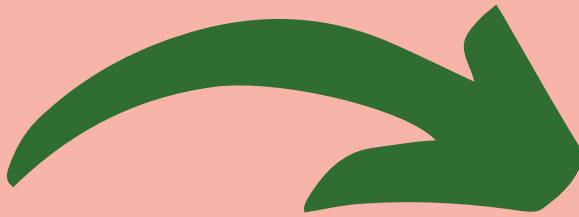
3. Click on the page and click on the red button to download java in the device used



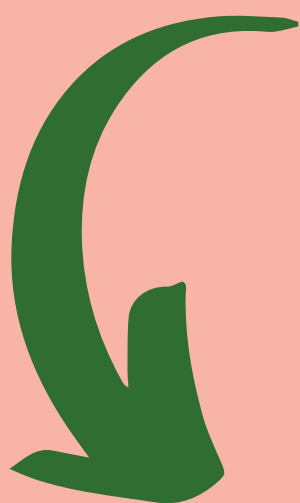
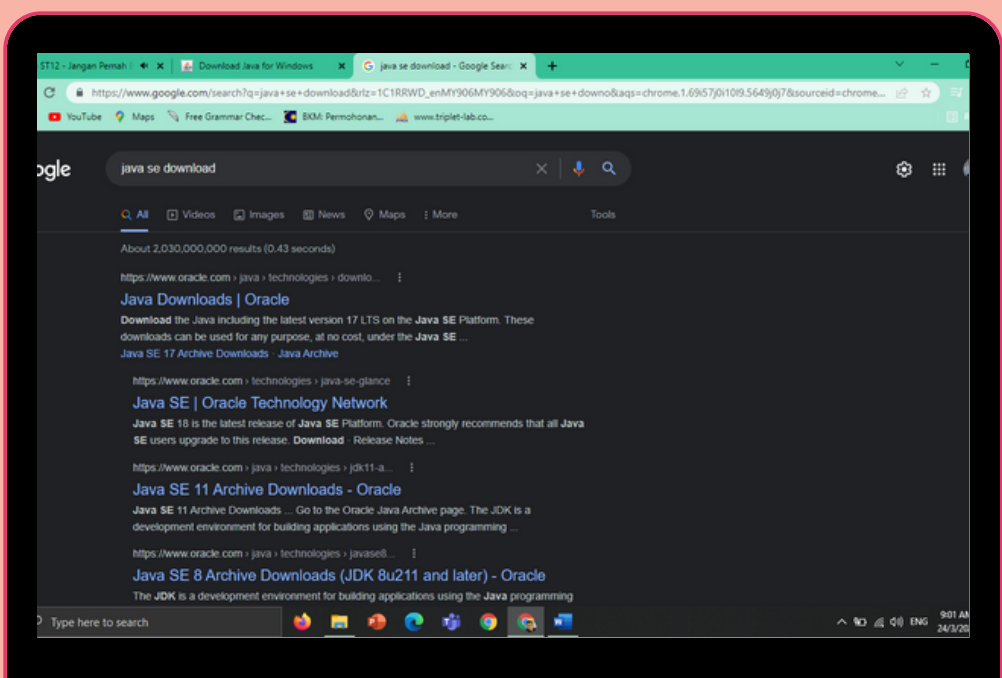
4. Java that has been downloaded will be stored in the file section



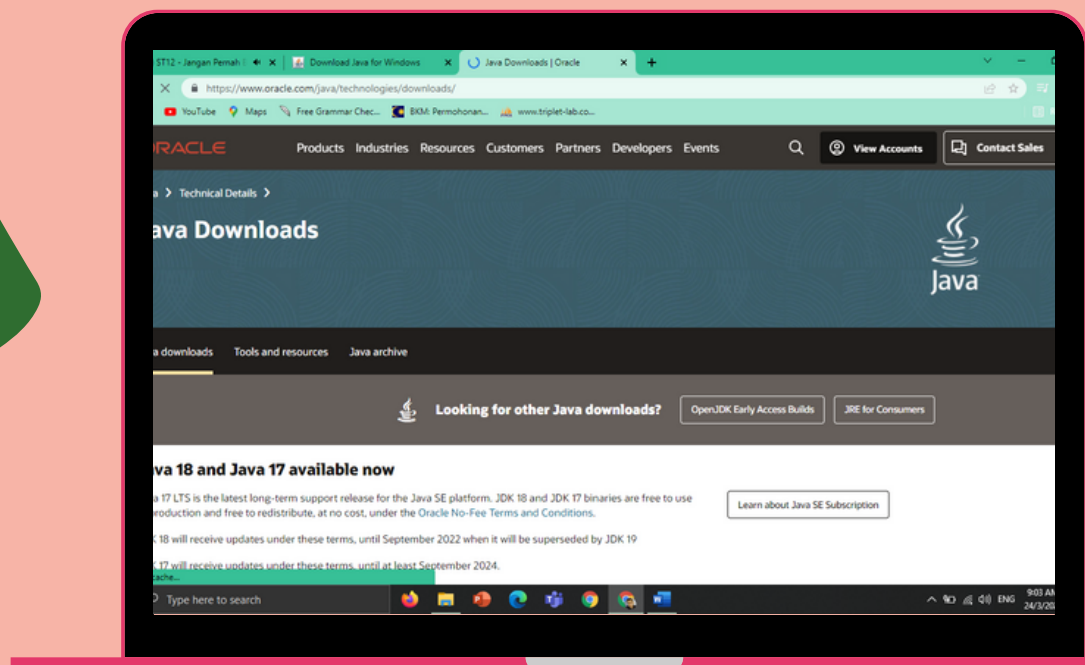
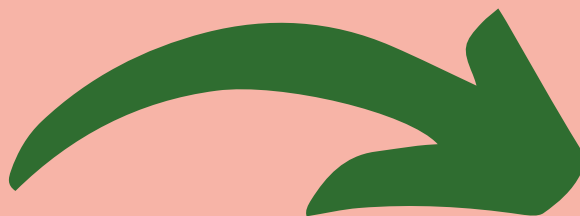
5. Then, we need to click on the downloaded file to download the file in the java



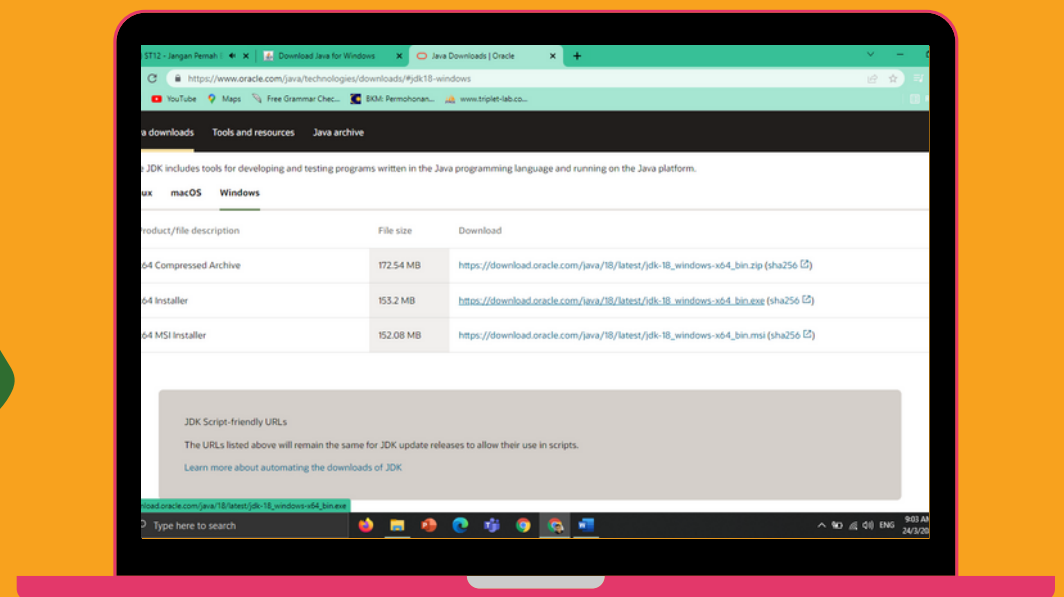
6. When finished downloading go to the next step which is to download Java se



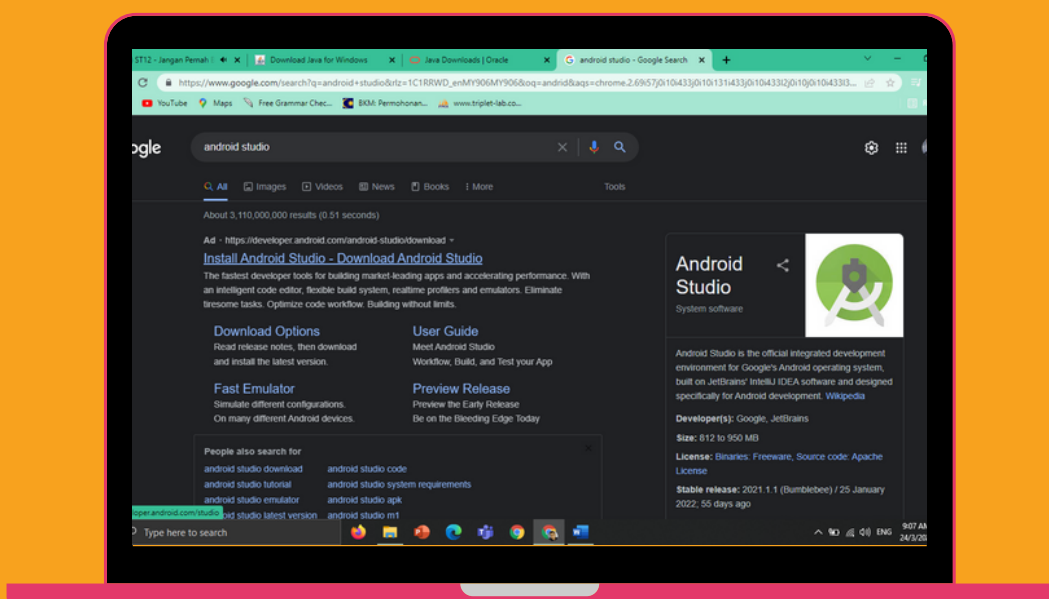
7. Click to enter page jdk 17



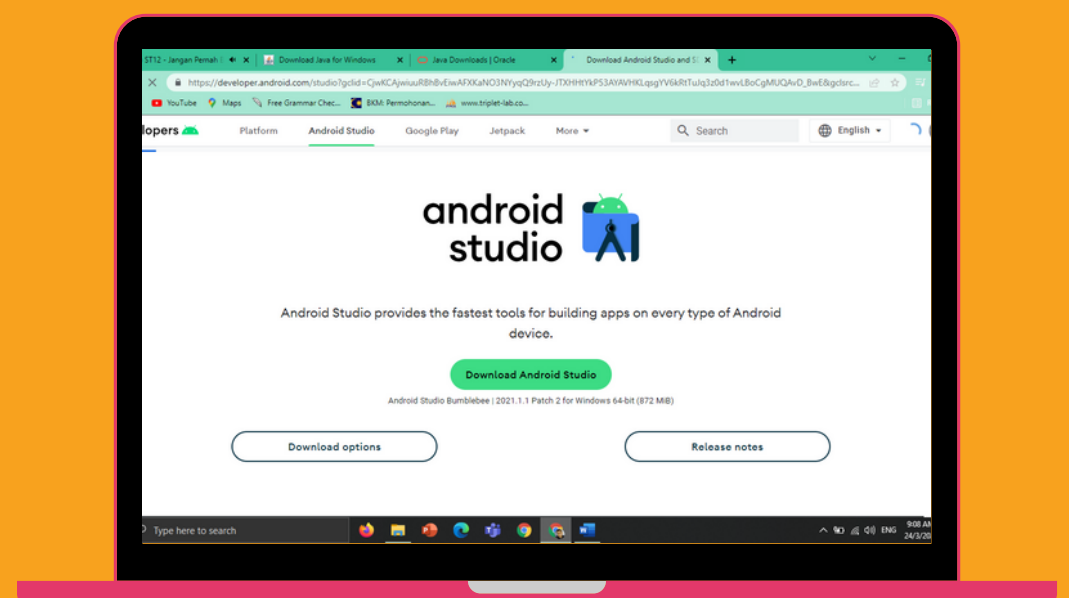
8. Click download on x64 installer



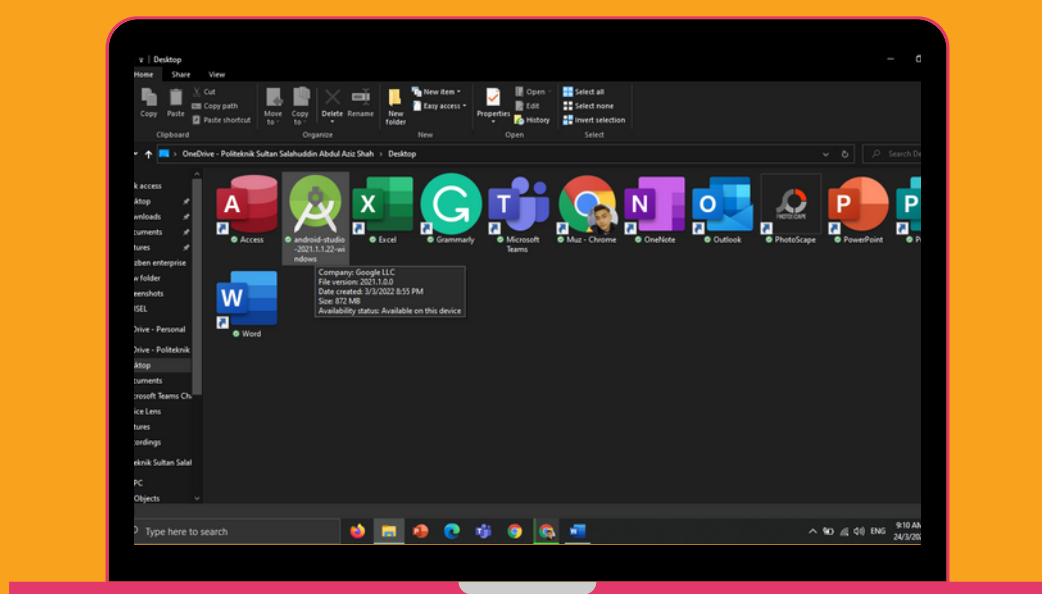
9. Then, we need to upload android studio



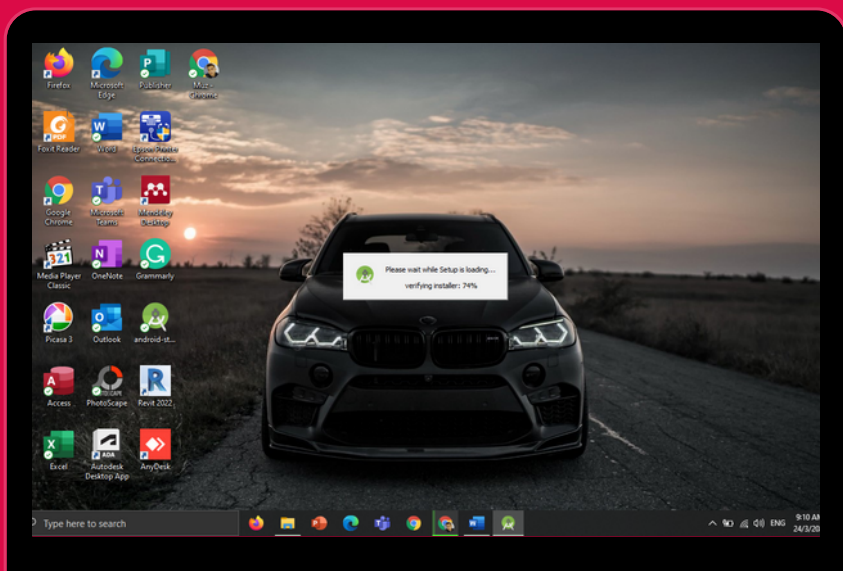
10. Click the download button to download android studio into the device



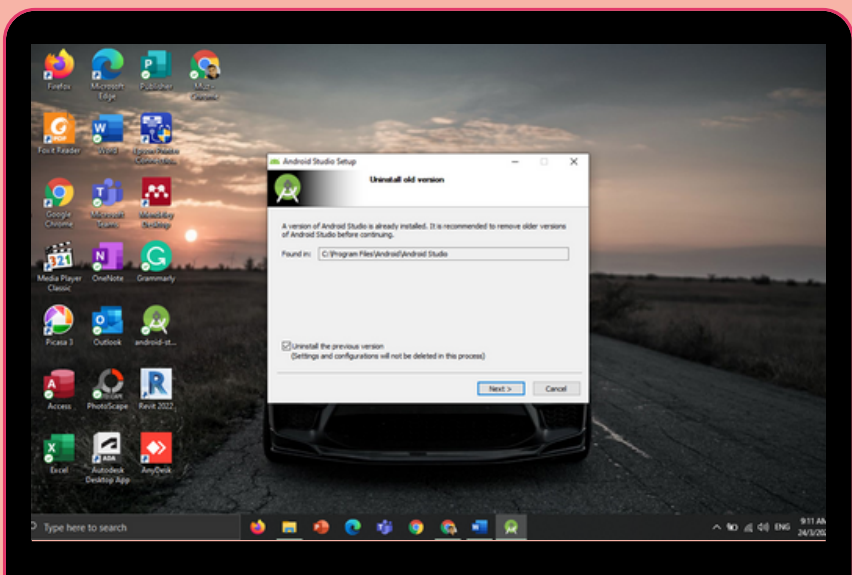
11. After finishing downloading android studio will be saved in a file



12. Click on the android studio file for running and download the file on the inside



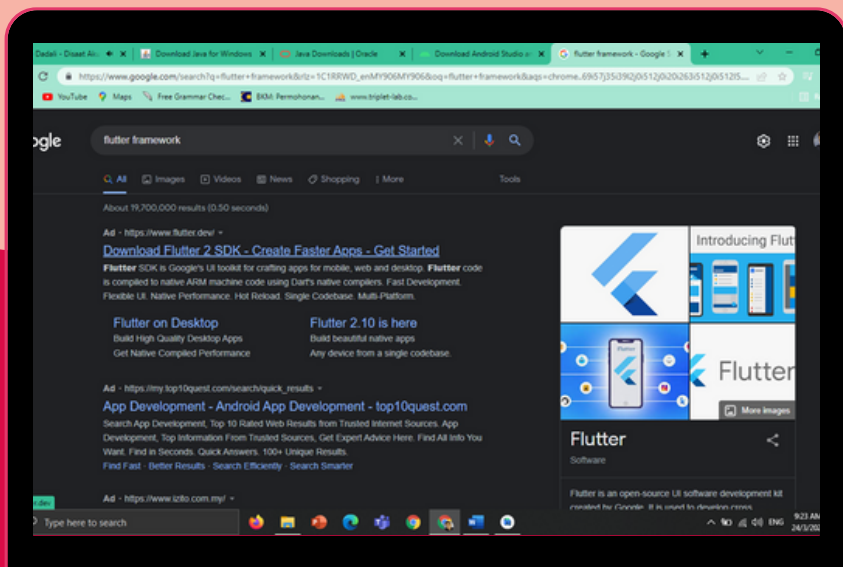
13. Click next button to continue downloading android studio



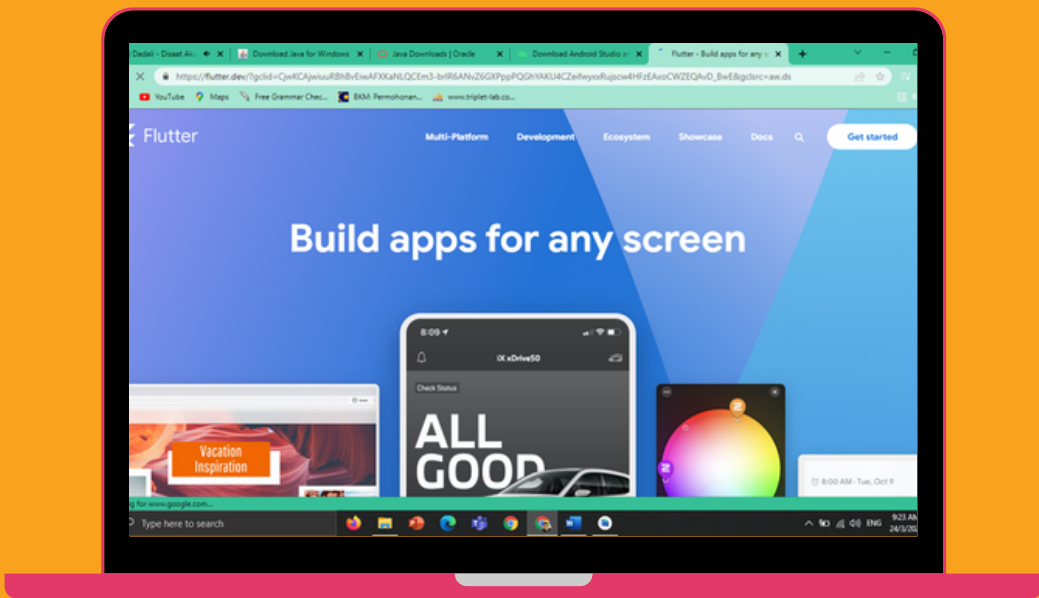
14. When finished downloading it will continue to bring to the front page of android studio



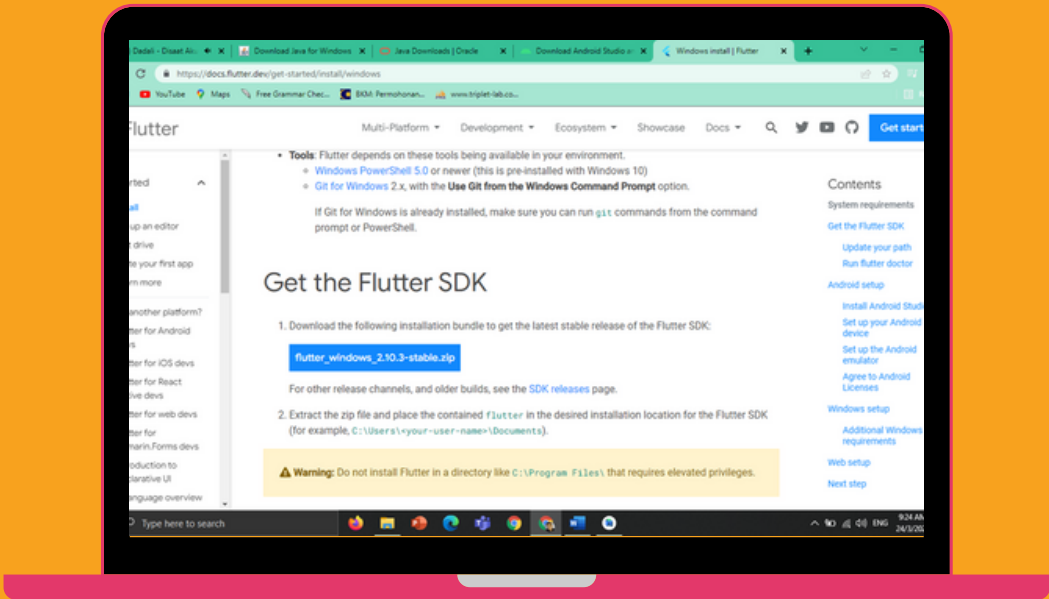
15. After that, download the flutter framework to complete the coding work



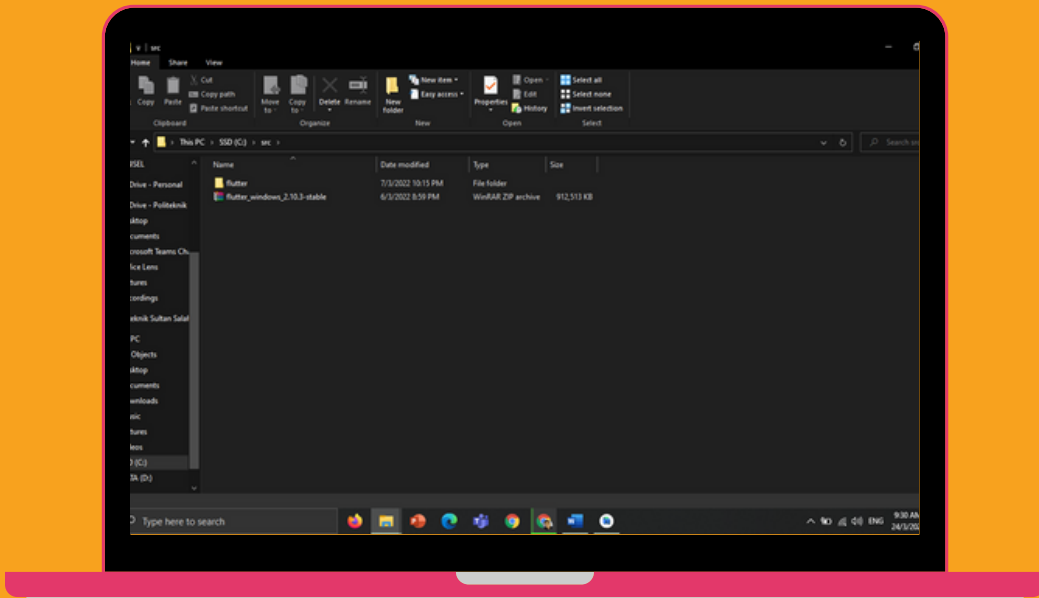
16. Click on the website to download the software



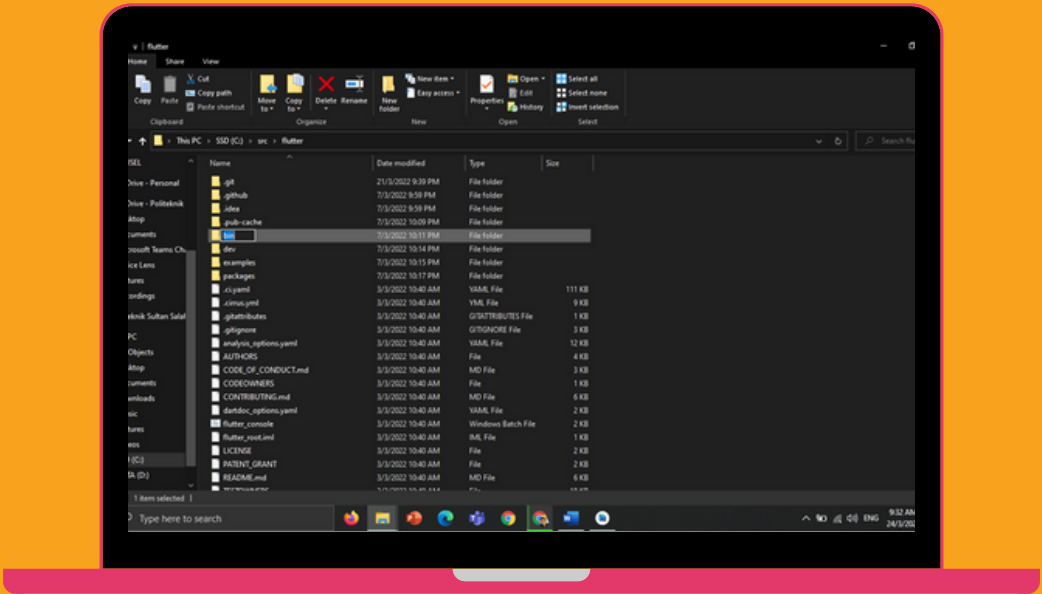
17. After entering the website, click on the blue button to download the flutter framework



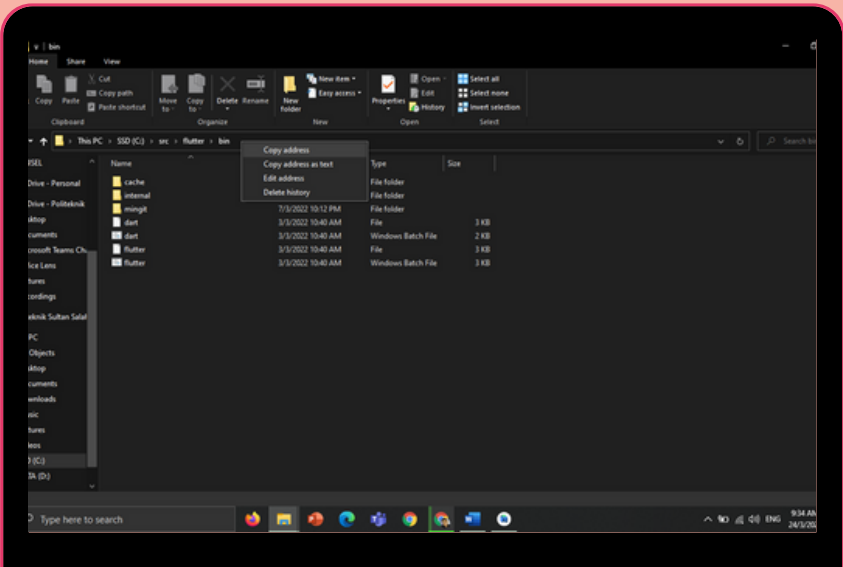
18. When finished downloading it will be saved in the file section on the dekstop



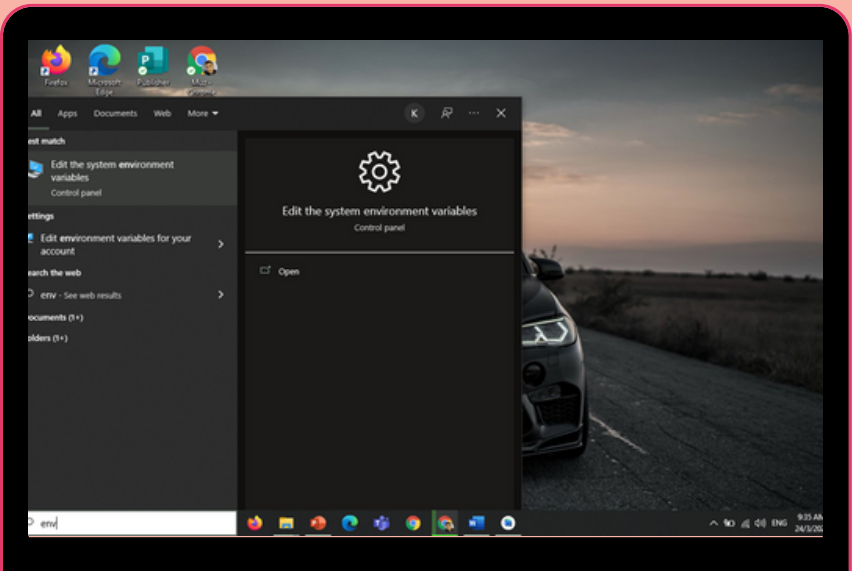
19. Open the file and click on the happy bin to see the data in the file



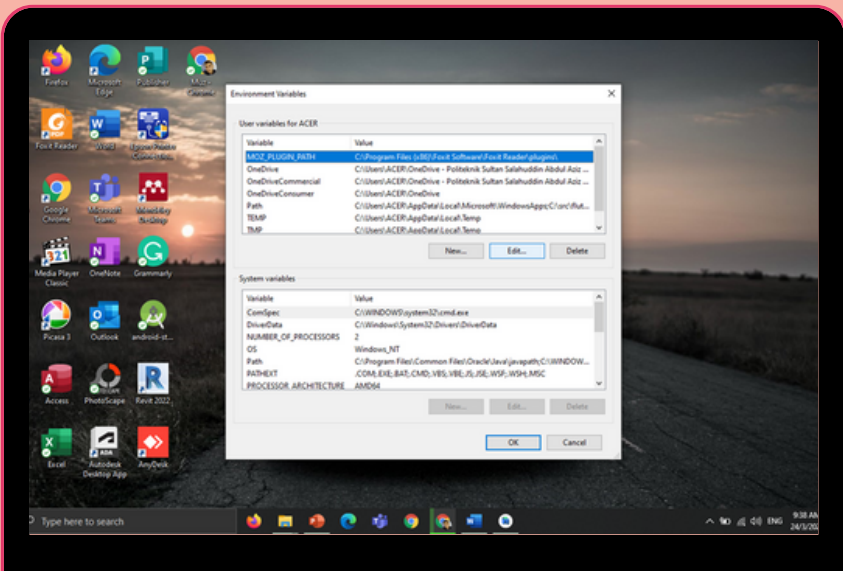
20. Copy the address in the bin file



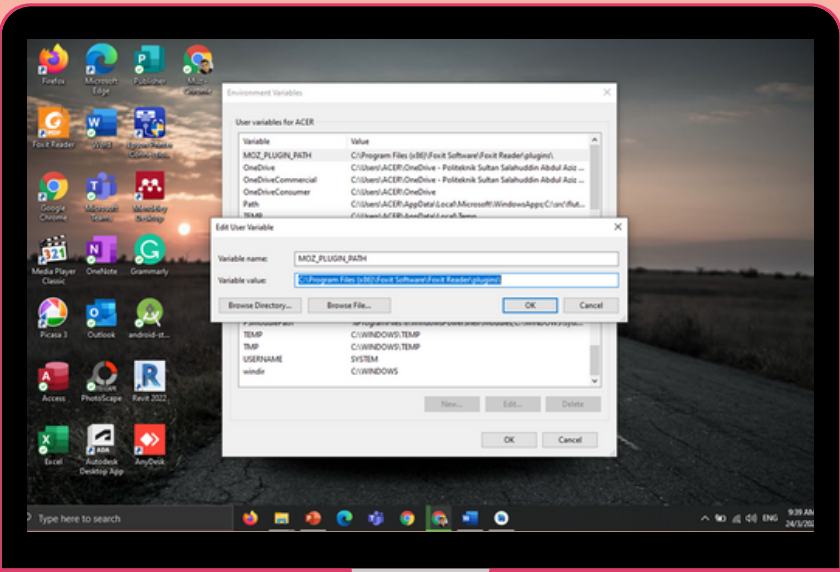
21. Then go to the search section and type env and click on edit environment variables for your account



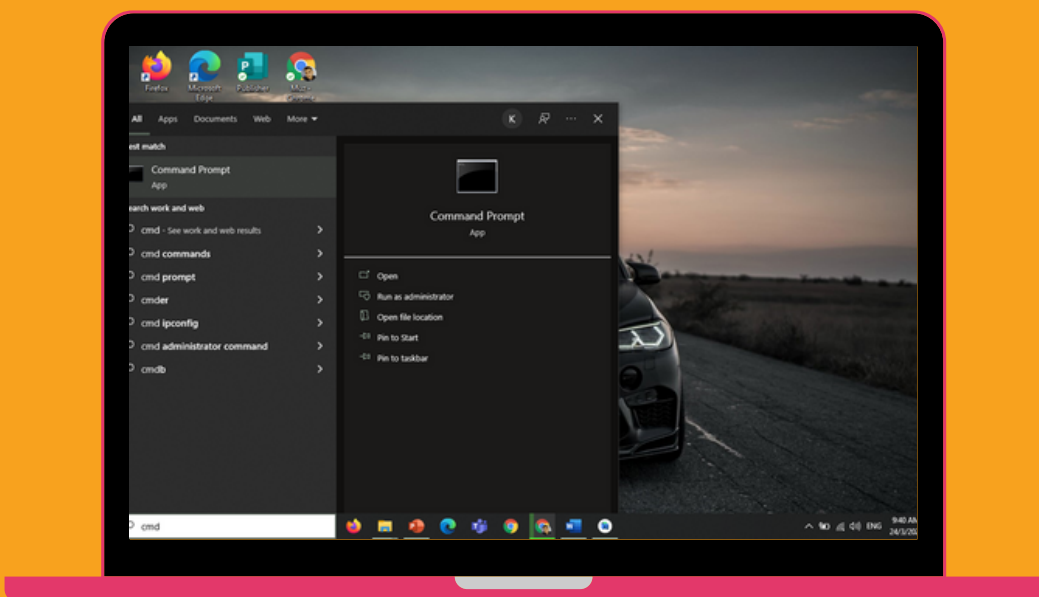
22. Next, Click on the edit button



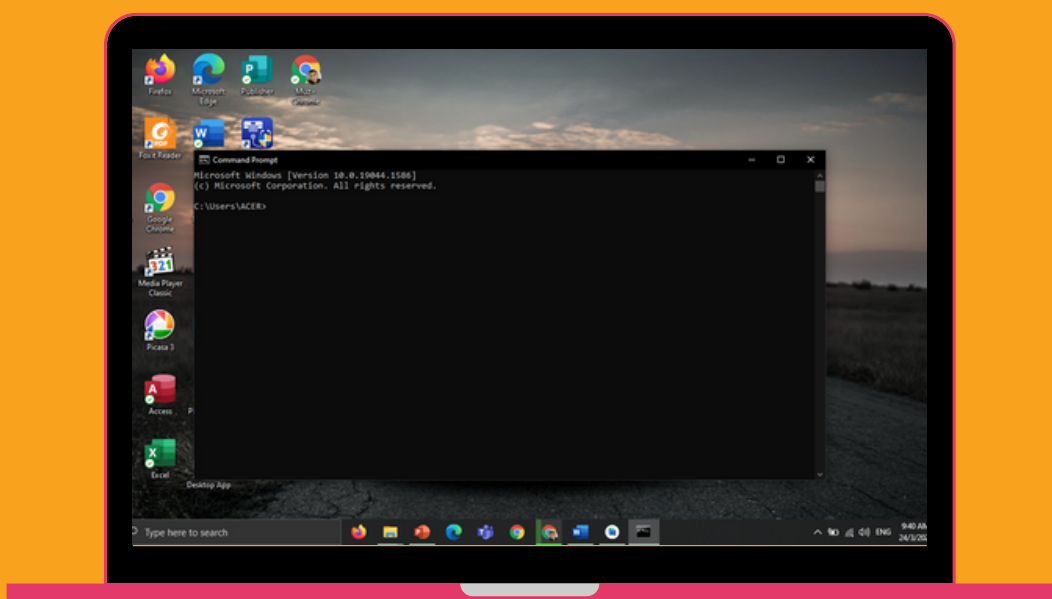
23. Then paste the address that was copied earlier



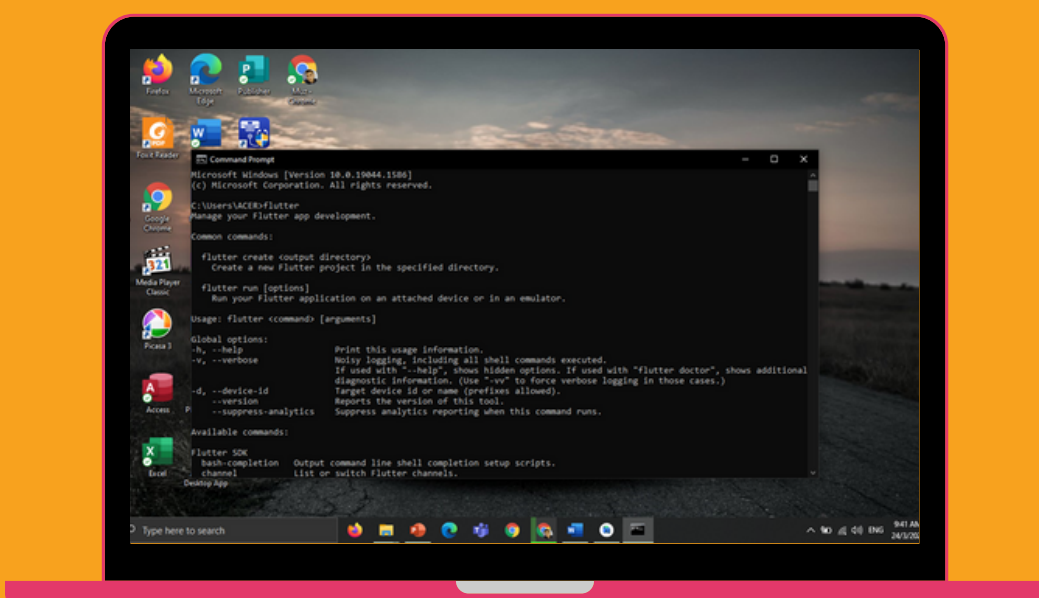
24. Then go to the search section again and type cmd and click on the command prompt



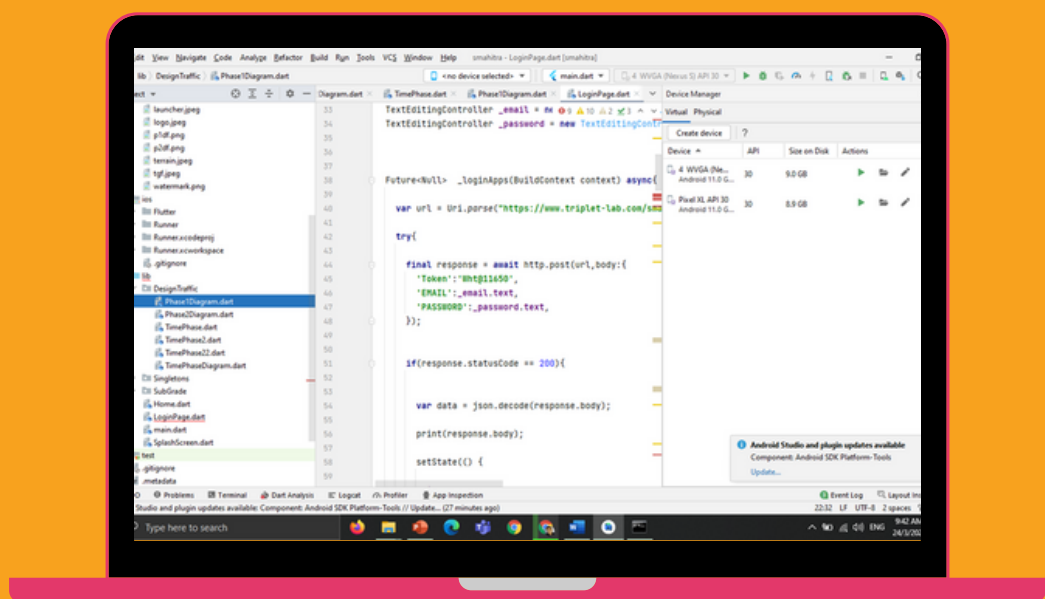
25. Type flutter to test whether flutter has been installed in the device or not



26. If the word flutter 'run' is written then flutter is fully downloaded

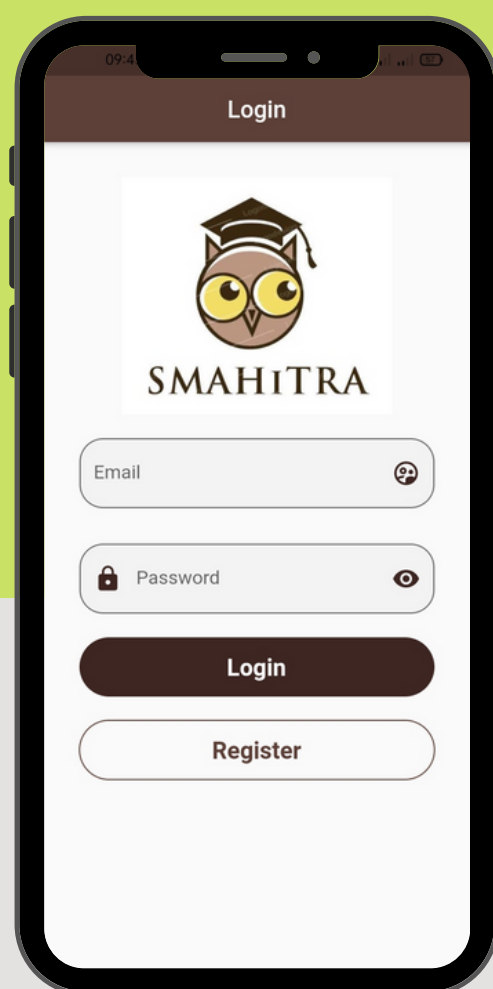


27. Finally, when complete downloading to the three devices we can start the coding work



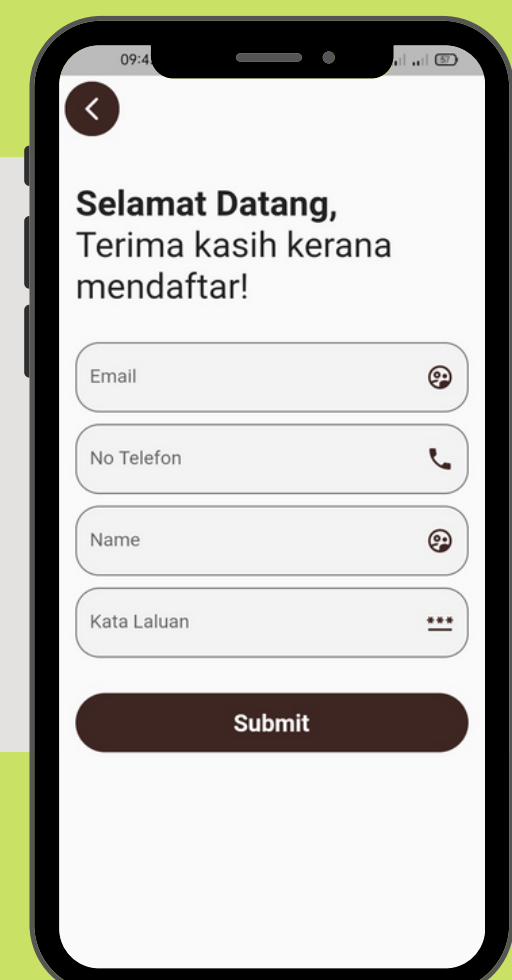
3.3 How to use SMAHiTRA applications

- This is the main display after opening the SMAHiTRA application

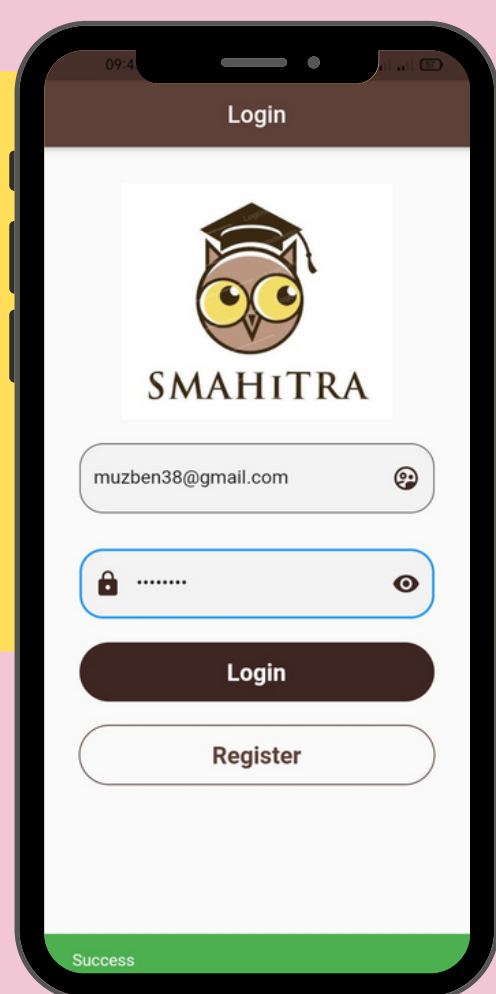
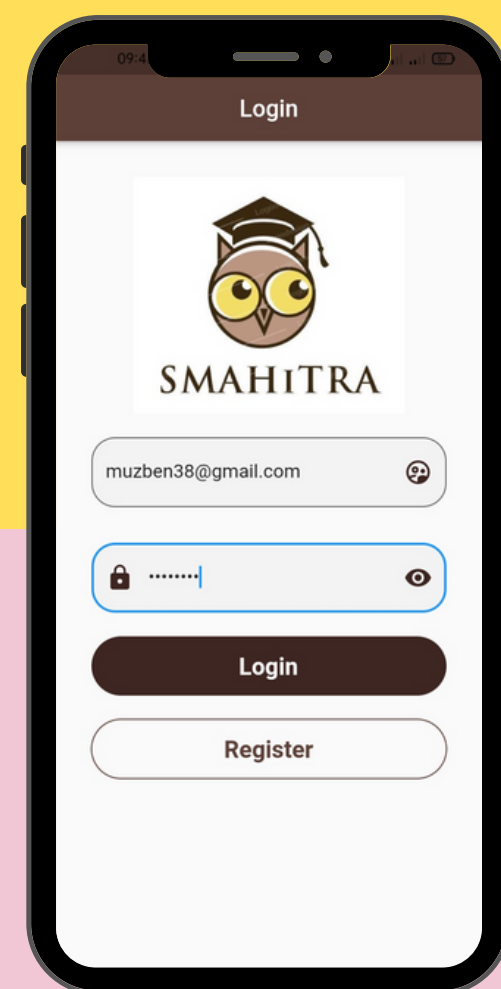


- Before logging in you need to register first

- Enter your email, phone number, name and password to register

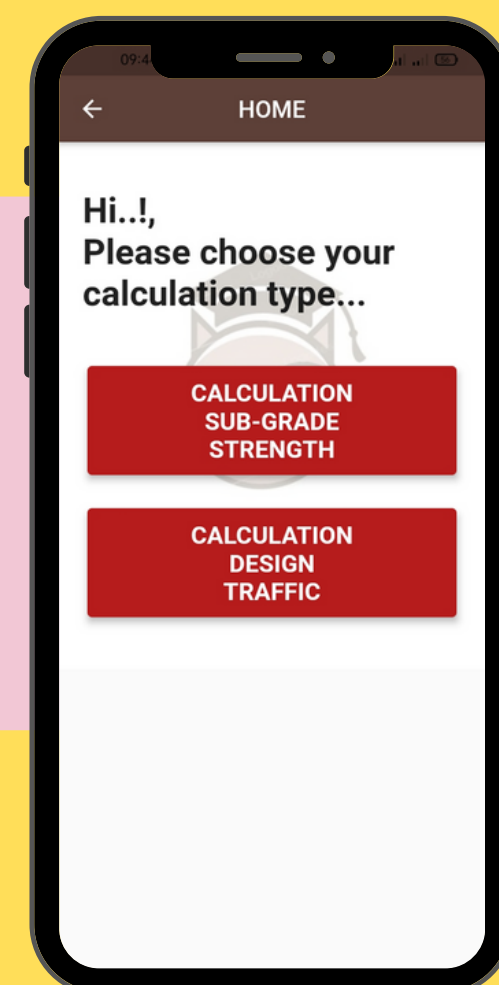


• After completing the registration you can log in by entering the email and password that has been registered

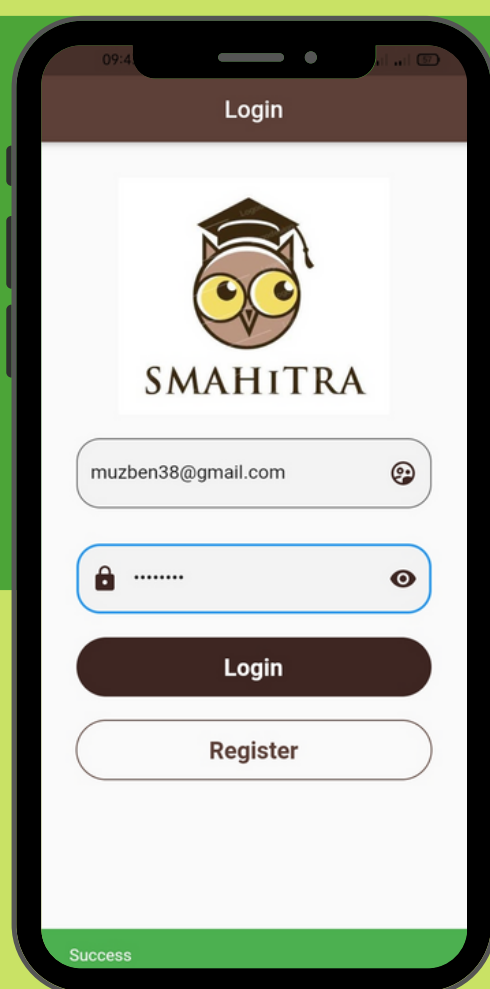
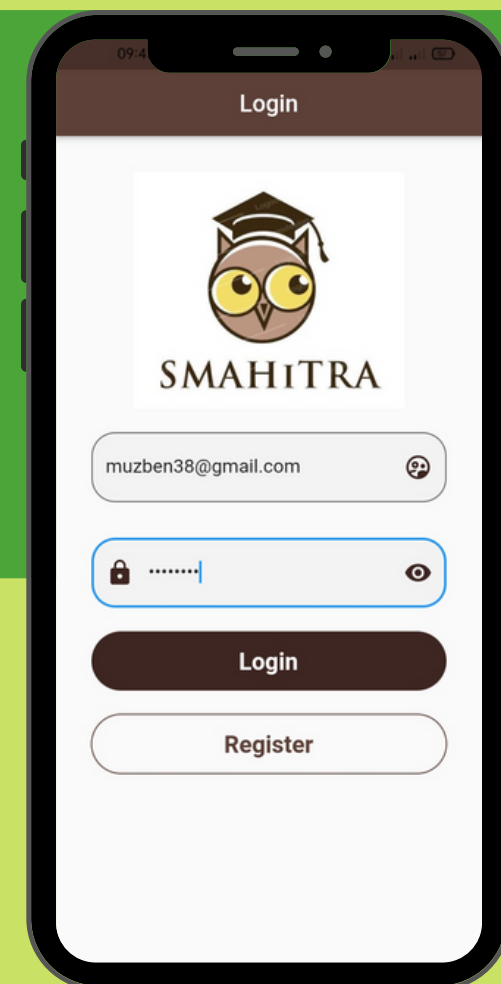


• If there is the word success after logging in, then the registered account is valid

• There are 2 types of calculations that can be used, namely subgrade category calculations and traffic design

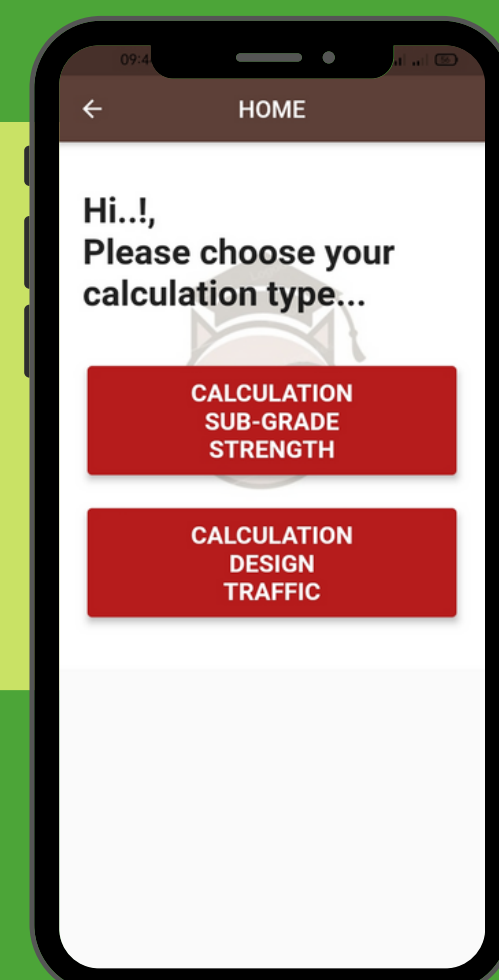


- After completing the registration you can log in by entering the email and password that has been registered



- If there is the word success after logging in, then the registered account is valid

- There are 2 types of calculations that can be used, namely subgrade category calculations and traffic design



• For sub-grade strength calculation you need to enter the value of average daily traffic (ADT), percentage of cv (Pcv), load equivalence factors of applicable vehicle class (LEF), lane distribution factors (L), and terrain factor (T)

SUB-GRADE STRENGTH

LEF = 3.7

L = 1.0

T = 1.3

TOTAL DAY = 365

Number of Lanes (in ONE direction)	Lane Distribution Factor, L
One	1.0
Two	0.9
Three or more	0.7

Type of Terrain	Terrain Factor, T
Flat	1.0
Rolling	1.1
Mountainous/Steep	1.3

CALCULATE

• Get the value of ESALy1 and need to enter the design period and annual growth rate to get the value of TGF

ANSWER

ESALy1

4.1714244

Design Period

10

Annual Growth Rate (%)

4

TGF

12.01

NEXT

• Then, get the type of traffic category and the value of design traffic over 20 years (ESALdes) multiplied by ESALy1 x TGF

TRAFFIC CATEGORY

ANSWER

50.0988070440000

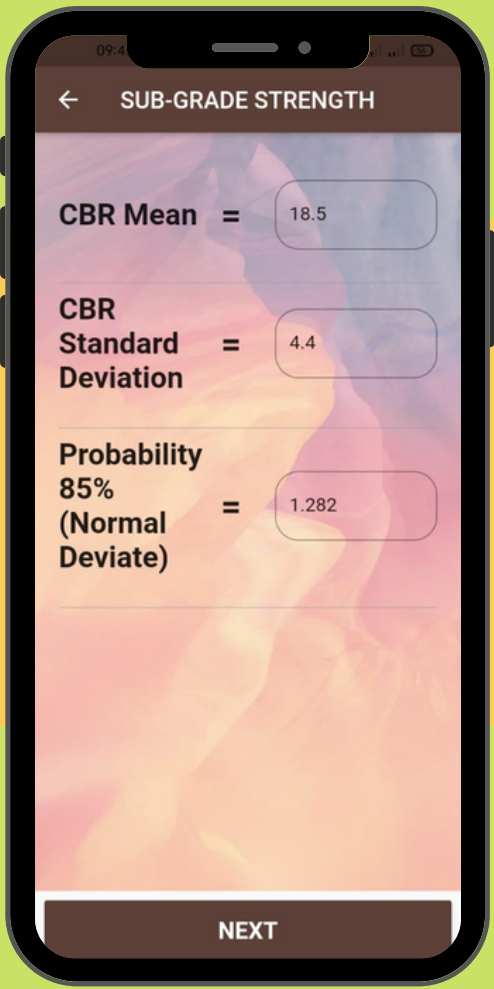
TRAFFIC CATEGORY

T5

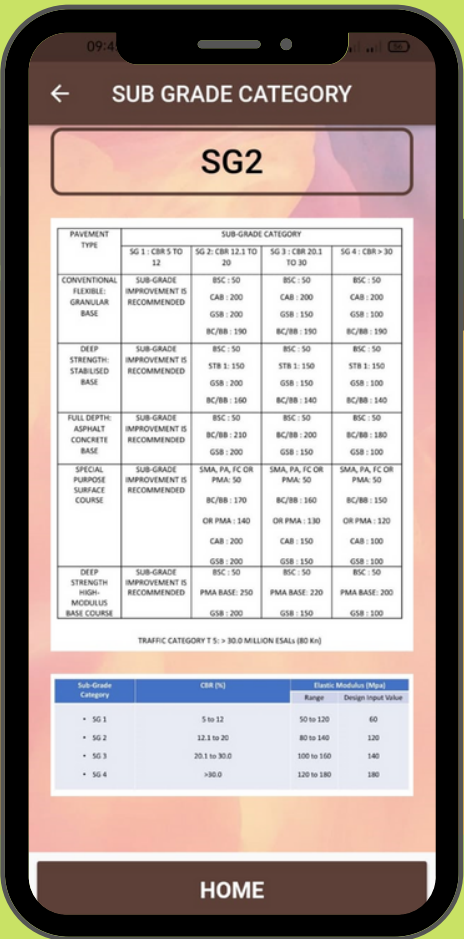
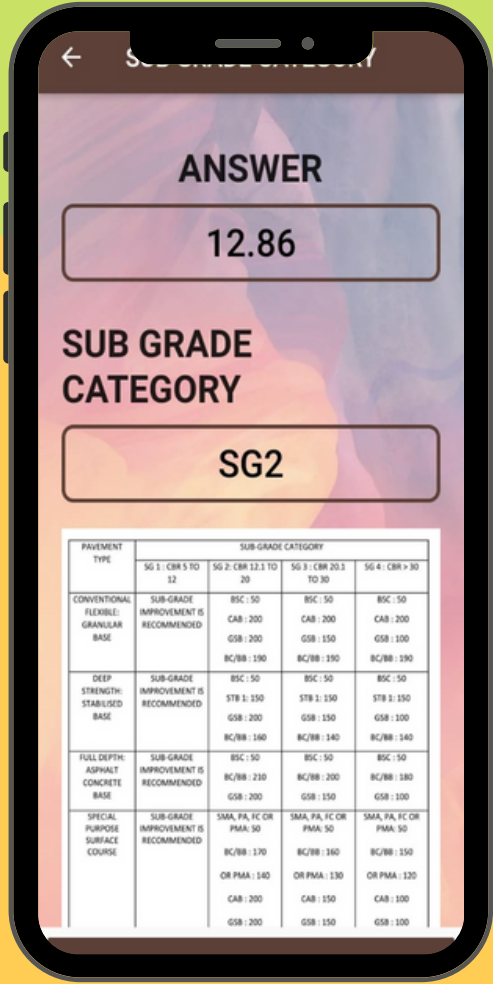
Traffic Category	Design Traffic (ESALs)	Probability (Percent) Applied to Properties of Sub-Grade Materials
T1	0.10	0.80%
T2	1.0 to 10.0	0.10%
T3	10.1 to 100.0	0.01%
T4	100.1 to 1000.0	0.001%
T5	> 1000.0	0.0001%

NEXT

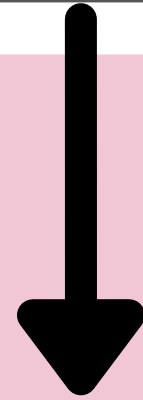
• CBR mean value, CBR standard deviation and probability 85% (normal deviate) must be stated to obtain the characteristic CBR value used for design



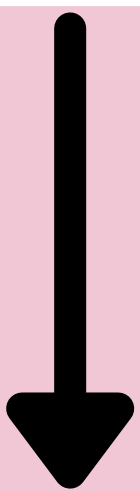
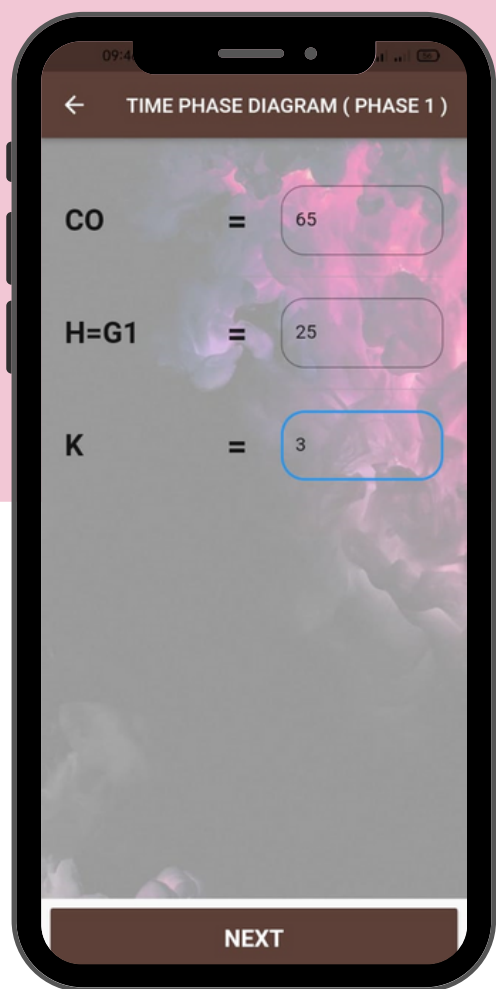
• Finally, get a CBR % value and a sub grade category



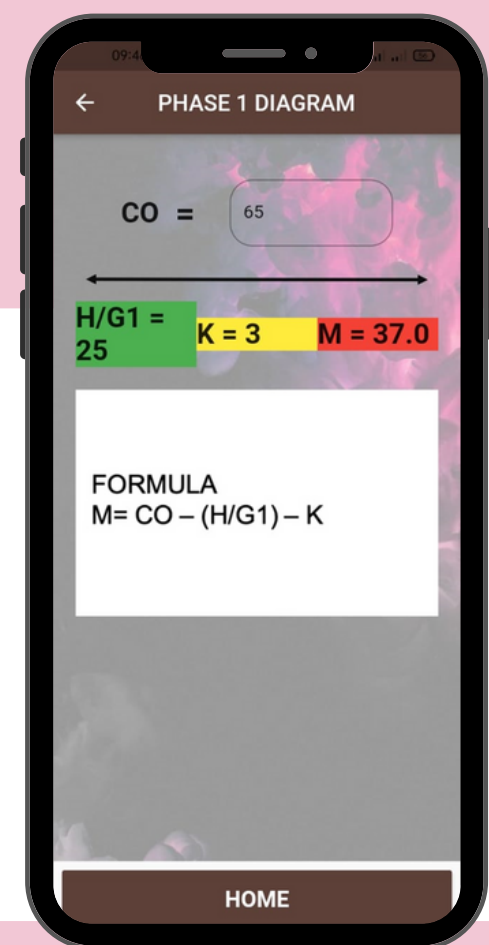
• For design traffic calculation, this application provides calculation for phase 1 and phase 2



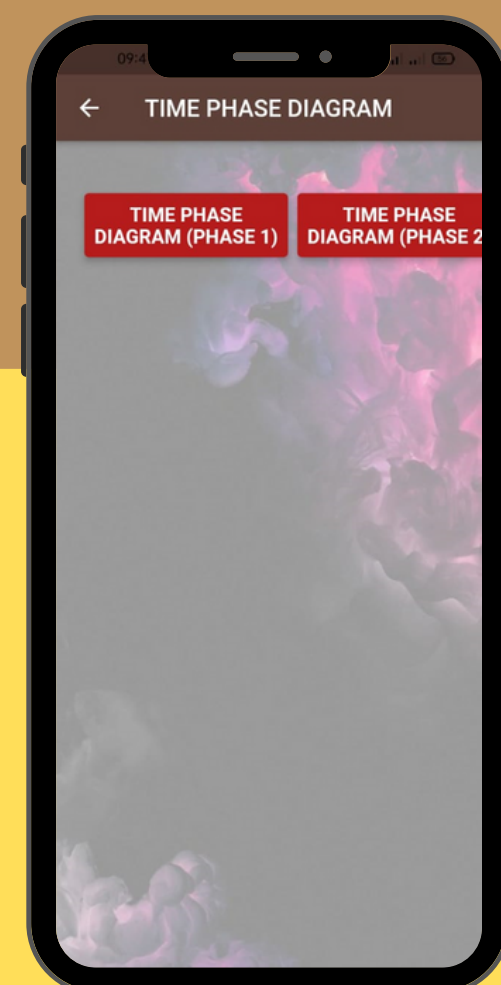
• For phase 1 - Enter the optimum cycle time (CO), actual green time phase 1 (G1 = H) and amber time (K)



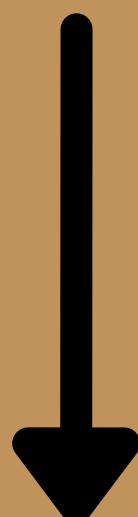
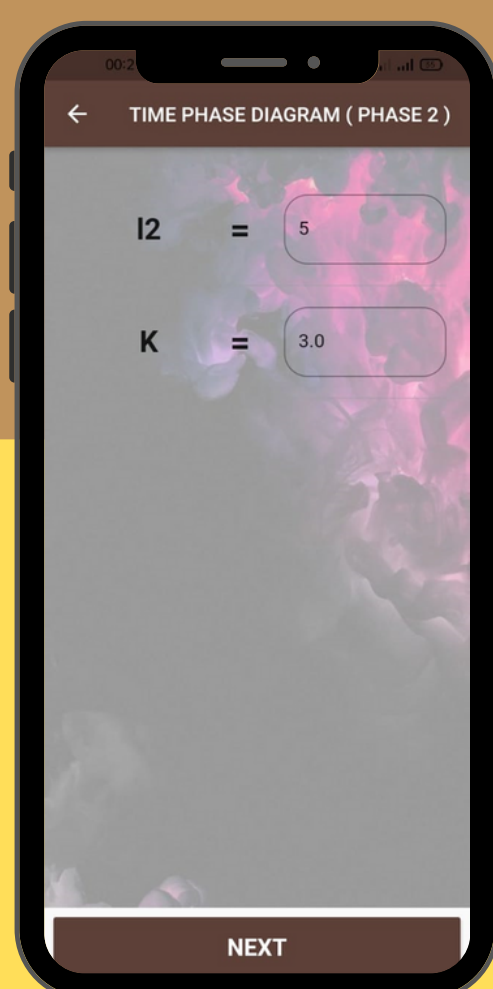
• Press next and get the time value on the red, yellow and green color traffic lights on phase 1 diagram



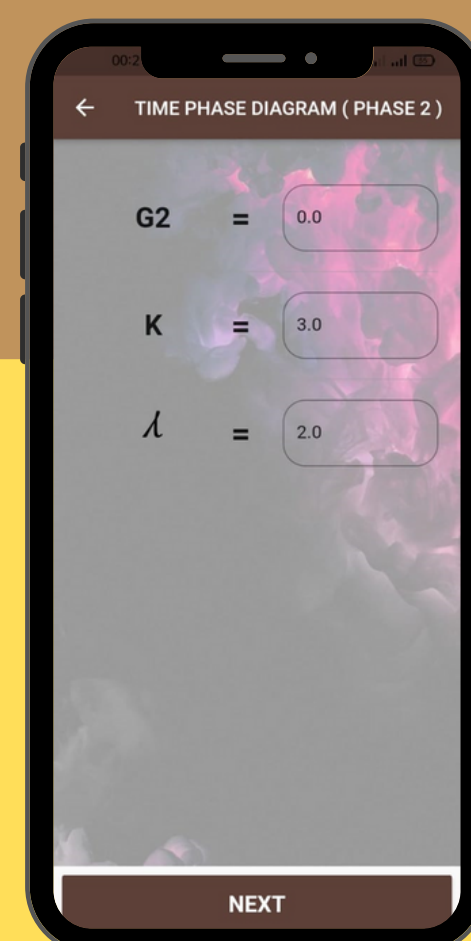
- Then, press the home button and press on the time phase diagram (phase 2)



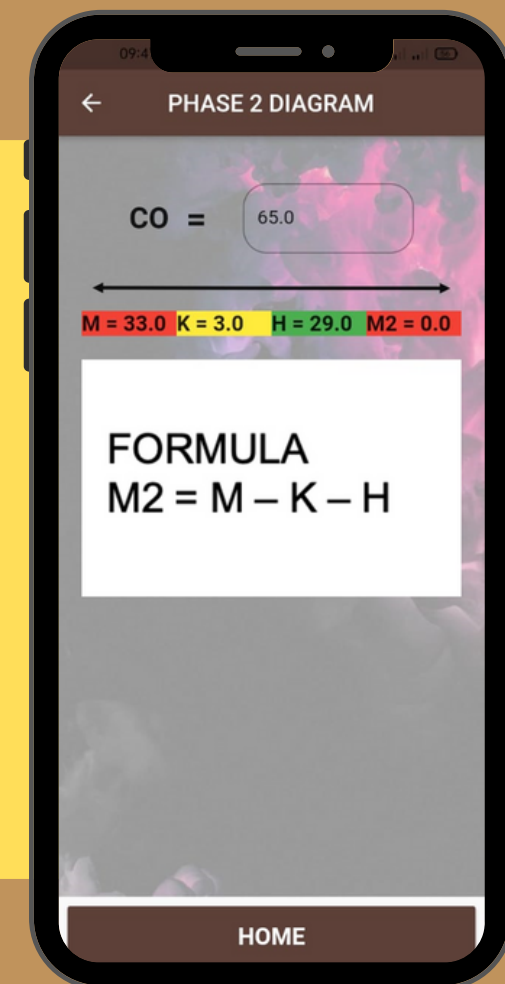
- Then enter the intergreen value 2 (I2) and amber time (K)



- Press the next button and also enter the values of actual green time phase 2 (G2), amber time (K) and ℓ



- Finally the time for each traffic light color will be shown in phase 2 diagram



If you can **DREAM** it, you can **DO** it.
(Walt Disney)



EXERCISE

QUESTION 1

A road with asphalt concrete base has a surface width of 7.0 and road shoulder of 1.25m is to be built as the main road in a residential area of flat terrain. Design a road pavement for Three or more lane highway with an average daily traffic 7000 veh/day. The rate of traffic growth is 6%. The percentage of commercial vehicles is 20 %. Design a flexible pavement by employing the JKR Malaysia Design Method for the road. The road design life is 25 years. FIND THE Esaly1 IN DETERMINE DESIGN TRAFFIC.

QUESTION 2

A road granular base has a surface width of 7.0 and road shoulder of 1.25m is to be built as a main road in a rolling terrain. Design a road pavement for Three or more lane highway with an average daily traffic 5000 veh/day. The rate of traffic growth is 8%. Percentage of commercial vehicle is 15 %. Design a flexible pavement by employing the JKR Malaysia Design Method for the road. The road design life is 15 years. Find the sub grade category.

EXERCISE

QUESTION 3

A road with stabilised base has a surfacewidth of 7.0 and road shoulder of 1.25m is to be built as a main road in a rolling terrain. Design a road pavement for two lane highway with an average daily traffic of 6000 veh/day. The rate of traffic growth is 7%. Percentage of commercial vehicle is 13 %. Design a flexible pavement by employing the JKR Malaysia Design Method for the road. The road design life is 10 years. Find the pavement structures

QUESTION 4

Design a road pavement for a TWO(2) lane highway with an average daily traffic of 5000 ,17% of commercial vehicle with un-laden weight > 1.5 tons. The following . additional project related information is available:

PCV = 17%

Lane Distributor Factor ,L = 1.0 (one lane in one direction)

Terrain factor, T = 1.0 (Flat)

Design life = 20 years

Annual Traffic Growth = 4.0%

Pavement Type = Granular base

FIND THE TRAFFIC CATEGORY

EXERCISE

QUESTION 5

Design a road pavement for a ONE(1) lane highway with an average daily traffic of 450, 17% of commercial vehicle with un-laden weight > 1.5 tons. The following additional project related information is available:

PCV = 17%

Lane Distributor Factor, $L = 1.0$ (one lane in one direction)

Terrain factor, $T = 1.1$ (rolling)

Design life = 30 years

Annual Traffic Growth = 7.0%

Pavement Type = Asphalt concrete base

Find the total growth factor (tgf)

EXERCISE

(JUNCTION DESIGN)

EXERCISE 1

Lane Group		North	South	East	West
Veh/hr	Motor cycle	300	670	550	220
(Kend/j)	Car	60	100	70	60
	Lorry	50	40	40	50
	Bus	45	35	45	40
Lane width (m)		4	4	3.5	3.5

Assume:

Amber time, $k = 3s$

Intregreen Time, $I = 5s$

Lost time, $I = 2s$

Given PCU conversion:

Motorcycle = 0.33

Car = 1.00

Lorry = 1.75

Bus = 2.25

Design a two phase traffic signal to accommodate the flow of traffic in that junction.

EXERCISE

The North – South movement, the intergreen period and lost time for starting and ending movement is 10s and 3s. For East-West, intergreen period and lost time is 9s and 2s. Assume amber period for both phases is 3s. Based on Table 1, determine:

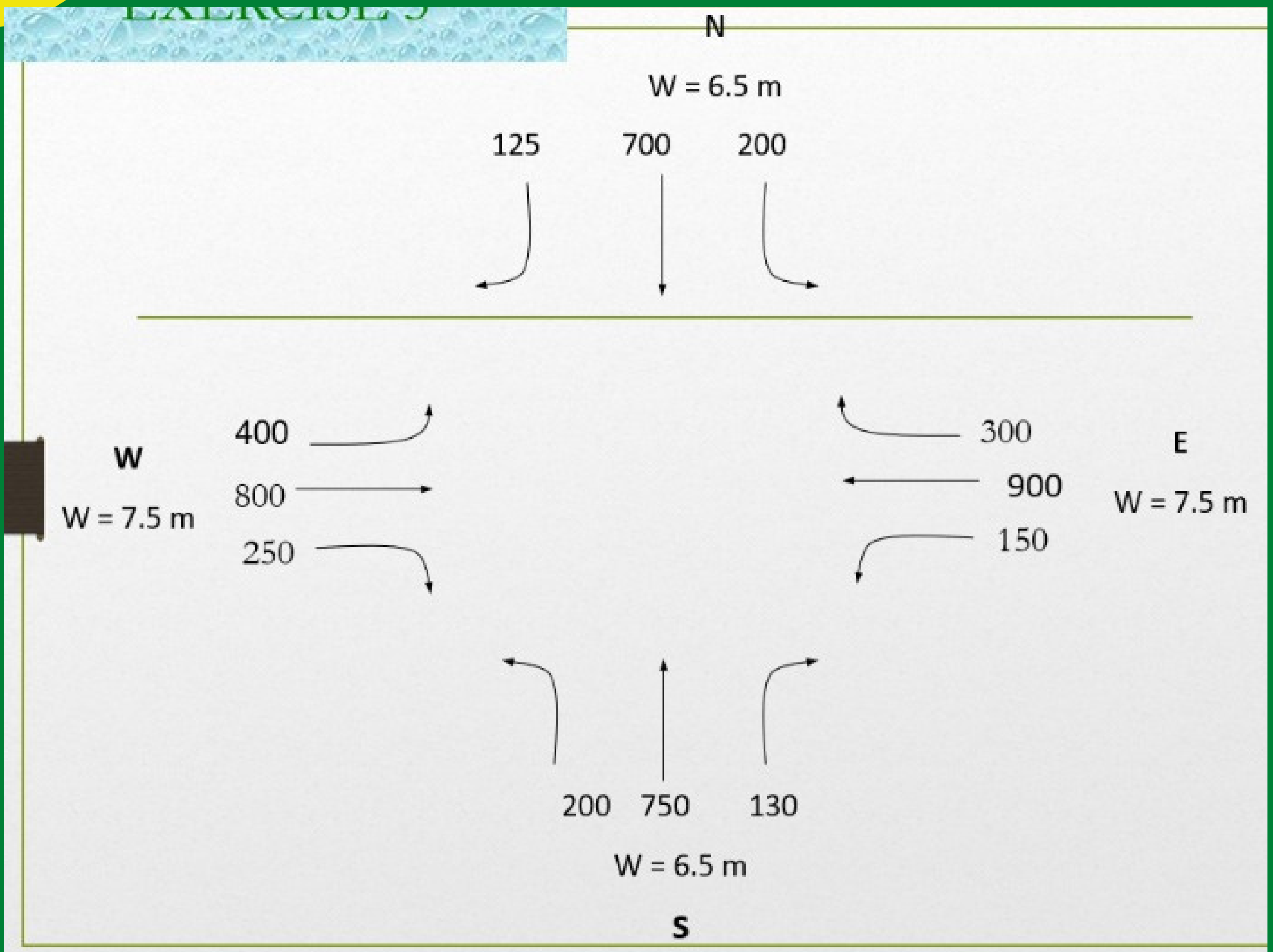
- i) Total time loss
- ii) Optimum time cycle
- iii) Effective green time for each phase
- iv) Actual green time for each phase

Yellow time = 3s

PHASE	NORTH	SOUTH	EAST	WEST
ACTUAL FLOW, Q (Pcu)	550	500	800	850
SATURATED	2400	2000	2500	3000

EXERCISE

EXERCISE 3



- Traffic flow direction (pcu/hr) and entry space lane width W (m) for a signalized junction given in the figure below. Design the traffic signal system for this at grade junction. Assume:-

Integreen period for N-S = 4 sec and E-W = 8 sec

Amber period for both phases is 3 sec

Lost time per phase is 2 sec

EXERCISE

EXERCISE 4

The North – South movement, the intergreen period and lost time for starting and ending movement is 10s and 3s. For East-West, intergreen period and lost time is 5s and 2s. Assume amber period for both phases is 2s. Based on Table 1, determine:

- i) Total time loss
- ii) Optimum time cycle
- iii) Effective green time for each phase
- iv) Actual green time for each phase

Yellow time = 3s

PHASE	NORTH	SOUTH	EAST	WEST
ACTUAL FLOW, Q (Pcu)	550	500	800	950
SATURATED	3000	2050	2000	3000

EXERCISE

EXERCISE 5

The peak hour volumes was observed for the unsignalized 4 legs junction on Jalan Sultan Idris Shah, Ipoh and tabulated in the Table below. Design a two phase traffic signal to accommodate the flow of traffic in that junction

LANE GROUP		NORTH	SOUTH	EAST	WEST
Veh/hr	motorcycle	300	670	550	220
Veh/hr	passenger car	60	100	70	60
Veh/hr	lorry	50	40	40	50
Veh/hr	bus	45	35	45	40
Lane width (m)		4	4	3.5	3.5

Given PCU conversion:

Motorcycle = 0.33 pcu

Passenger car = 1.00 pcu

Lorry = 1.75 pcu

Bus = 2.25pcu

Assume:

Amber Time, a: 3 sec

Intergreen Time, I: 5 sec

Lost Time, l: 2 sec

APPENDIX

PAVEMENT TYPE	SUB-GRADE CATEGORY			
	SG <u>1</u> : CBR 5 TO 12	SG 2: CBR 12.1 TO 20	SG <u>3</u> : CBR 20.1 TO 30	SG <u>4</u> : CBR > 30
CONVENTIONAL FLEXIBLE: GRANULAR BASE	<u>BSC</u> : 50 <u>CAB</u> : 250 <u>GSB</u> : 150	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 150	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 100	<u>BSC</u> : 50 <u>CAB</u> : 100 <u>GSB</u> : 100
DEEP STRENGTH: STABILISED BASE	<u>BSC</u> : 50 STB 2: 100 <u>GSB</u> : 200	<u>BSC</u> : 50 STB 2: 100 <u>GSB</u> : 150	<u>BSC</u> : 50 STB 2: 100 <u>GSB</u> : 100	<u>BSC</u> : 50 STB 2: 100 <u>GSB</u> : 100
STABILISED BASE WITH SURFACE TREATMENT	GSB: 300 OR STB 2: 250	GSB: 300 OR STB 2: 250	GSB: 250 OR STB 2: 200	GSB: 250 OR STB 2: 200

TRAFFIC CATEGORY T 1: < 1.0 MILLION ESALs (80 Kn)

PAVEMENT TYPE	SUB-GRADE CATEGORY			
	SG <u>1</u> : CBR 5 TO 12	SG 2: CBR 12.1 TO 20	SG <u>3</u> : CBR 20.1 TO 30	SG <u>4</u> : CBR > 30
CONVENTIONAL FLEXIBLE: GRANULAR BASE	<u>BSC</u> : 140 <u>CAB</u> : 200 <u>GSB</u> : 150	<u>BSC</u> : 140 <u>CAB</u> : 200 <u>GSB</u> : 150	<u>BSC</u> : 120 <u>CAB</u> : 200 <u>GSB</u> : 100	<u>BSC</u> : 100 <u>CAB</u> : 200 <u>GSB</u> : 100
DEEP STRENGTH: STABILISED BASE	<u>BSC</u> : 120 STB 2: 150 <u>GSB</u> : 200	<u>BSC</u> : 120 STB 2: 150 <u>GSB</u> : 150	<u>BSC</u> : 100 STB 2: 120 <u>GSB</u> : 150	<u>BSC</u> : 100 STB 2: 120 <u>GSB</u> : 150
FULL DEPTH: ASPHALT CONCRETE BASE	<u>BSC</u> : 50 <u>BB</u> : 100 <u>GSB</u> : 250	<u>BSC</u> : 50 <u>BB</u> : 100 <u>GSB</u> : 200	<u>BSC</u> : 50 <u>BB</u> : 100 <u>GSB</u> : 150	<u>BSC</u> : 50 <u>BB</u> : 80 <u>GSB</u> : 150

TRAFFIC CATEGORY T 2: 1.0 to 2.0 MILLION ESALs (80 Kn)

APPENDIX

PAVEMENT TYPE	SUB-GRADE CATEGORY			
	SG 1 : CBR 5 TO 12	SG 2: CBR 12.1 TO 20	SG 3 : CBR 20.1 TO 30	SG 4 : CBR > 30
CONVENTIONAL FLEXIBLE: GRANULAR BASE	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 200 <u>BC</u> : 130	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 200 <u>BC</u> : 130	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 150 <u>BC</u> : 130	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 100 <u>BC</u> : 130
DEEP STRENGTH: STABILISED BASE	<u>BSC</u> : 50 STB 1: 150 <u>GSB</u> : 200 <u>BC</u> : 100	<u>BSC</u> : 50 STB 1: 150 <u>GSB</u> : 150 <u>BC</u> : 100	<u>BSC</u> : 50 STB 1: 100 <u>GSB</u> : 150 <u>BC</u> : 100	<u>BSC</u> : 50 STB 1: 100 <u>GSB</u> : 100 <u>BC</u> : 100
FULL DEPTH: ASPHALT CONCRETE BASE	<u>BSC</u> : 50 <u>BC/BB</u> : 160 <u>GSB</u> : 200	<u>BSC</u> : 50 <u>BC/BB</u> : 150 <u>GSB</u> : 150	<u>BSC</u> : 50 <u>BC/BB</u> : 130 <u>GSB</u> : 150	<u>BSC</u> : 50 <u>BC/BB</u> : 130 <u>GSB</u> : 100

TRAFFIC CATEGORY T 3: 1.0 to 2.0 MILLION ESALs (80 Kn)

PAVEMENT TYPE	SUB-GRADE CATEGORY			
	SG 1 : CBR 5 TO 12	SG 2: CBR 12.1 TO 20	SG 3 : CBR 20.1 TO 30	SG 4 : CBR > 30
CONVENTIONAL FLEXIBLE: GRANULAR BASE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 200 <u>BC/BB</u> : 150	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 150 <u>BC/BB</u> : 160	<u>BSC</u> : 50 <u>CAB</u> : 200 <u>GSB</u> : 100 <u>BC/BB</u> : 150
DEEP STRENGTH: STABILISED BASE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>BSC</u> : 50 STB 1: 120 <u>GSB</u> : 200 <u>BC/BB</u> : 150	<u>BSC</u> : 50 STB 1: 100 <u>GSB</u> : 150 <u>BC/BB</u> : 140	<u>BSC</u> : 50 STB 1: 100 <u>GSB</u> : 100 <u>BC/BB</u> : 130
FULL DEPTH: ASPHALT CONCRETE BASE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>BSC</u> : 50 <u>BC/BB</u> : 200 <u>GSB</u> : 200	<u>BSC</u> : 50 <u>BC/BB</u> : 180 <u>GSB</u> : 150	<u>BSC</u> : 50 <u>BC/BB</u> : 150 <u>GSB</u> : 100

TRAFFIC CATEGORY T 4: 10.0 to 30.0 MILLION ESALs (80 Kn)

APPENDIX

PAVEMENT TYPE	SUB-GRADE CATEGORY			
	SG 1: CBR 5 TO 12	SG 2: CBR 12.1 TO 20	SG 3: CBR 20.1 TO 30	SG 4: CBR > 30
CONVENTIONAL FLEXIBLE: GRANULAR BASE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>RSC</u> : 50 <u>CAR</u> : 200 <u>GSR</u> : 200 <u>BC/BB</u> : 190	<u>RSC</u> : 50 <u>CAR</u> : 200 <u>GSR</u> : 150 <u>BC/BB</u> : 190	<u>RSC</u> : 50 <u>CAR</u> : 200 <u>GSR</u> : 100 <u>BC/BB</u> : 190
DEEP STRENGTH: STABILISED BASE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>RSC</u> : 50 STB 1: 150 <u>GSR</u> : 200 <u>BC/BB</u> : 160	<u>RSC</u> : 50 STB 1: 150 <u>GSR</u> : 150 <u>BC/BB</u> : 140	<u>RSC</u> : 50 STB 1: 150 <u>GSR</u> : 100 <u>BC/BB</u> : 140
FULL DEPTH: ASPHALT CONCRETE BASE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>RSC</u> : 50 <u>BC/BB</u> : 210 <u>GSR</u> : 200	<u>RSC</u> : 50 <u>BC/BB</u> : 200 <u>GSR</u> : 150	<u>RSC</u> : 50 <u>BC/BB</u> : 180 <u>GSR</u> : 100
SPECIAL PURPOSE SURFACE COURSE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	SMA, PA, FC OR PMA: 50 <u>BC/BB</u> : 170 OR <u>PMA</u> : 140 <u>CAR</u> : 200 <u>GSR</u> : 200	SMA, PA, FC OR PMA: 50 <u>BC/BB</u> : 160 OR <u>PMA</u> : 130 <u>CAR</u> : 150 <u>GSR</u> : 150	SMA, PA, FC OR PMA: 50 <u>BC/BB</u> : 150 OR <u>PMA</u> : 120 <u>CAR</u> : 100 <u>GSR</u> : 100
DEEP STRENGTH HIGH-MODULUS BASE COURSE	SUB-GRADE IMPROVEMENT IS RECOMMENDED	<u>RSC</u> : 50 PMA BASE: 250 <u>GSR</u> : 200	<u>RSC</u> : 50 PMA BASE: 220 <u>GSR</u> : 150	<u>RSC</u> : 50 PMA BASE: 200 <u>GSR</u> : 100

TRAFFIC CATEGORY T 5: > 30.0 MILLION ESALs (80 Kn)

APPENDIX

LANE DISTRIBUTION FACTORS

Number of Lanes (In ONE direction)	Lane Distribution Factor, L
One	1.0
Two	0.9
Three or more	0.7

Terrain Factors

Type of terrain	Terrain Factor, T
Flat	1.0
Rolling	1.1
Mountainous/Steep	1.3

Total Growth Factors (TGF)

Design Period (Years)	Annual Growth Rate (%)					
	2	3	4	5	6	7
10	10.95	11.46	12.01	12.58	13.18	13.82
15	17.29	18.60	20.02	21.58	23.28	25.13
20	24.30	26.87	29.78	33.06	36.79	41.00
25	32.03	36.46	41.65	47.73	54.86	63.25
30	40.57	47.58	56.08	66.44	79.06	94.46

APPENDIX

Traffic Categories used in this manual (ESAL = 80 KN)

Traffic Category	Design Traffic (ESAL X 10 ⁶)	Probability (Percentile) Applied to Properties of Sub-Grade Materials
• T 1	≤ 1.0	≥ 60%
• T 2	1.1 to 2.0	≥ 70%
• T 3	2.1 to 10.0	≥ 85%
• T 4	10.1 to 30.0	≥ 85%
• T 5	> 30.0	≥ 85%

Classes of Sub-Grade Strength (based on CBR) used as input in the Pavement Catalogue of This Manual

Sub-Grade Category	CBR (%)	Elastic Modulus (Mpa)	
		Range	Design Input Value
• SG 1	5 to 12	50 to 120	60
• SG 2	12.1 to 20	80 to 140	120
• SG 3	20.1 to 30.0	100 to 160	140
• SG 4	>30.0	120 to 180	180

ANSWER

EXERCISE ATJ FORM 2013

QUESTION 1

ANSWER = 1.32349 MILLION

QUESTION 2

ANSWER = SUB GRADE CATEGORY 2

QUESTION 3

Answer = BSC : 50

STB 1 : 120

GSB : 200

BC/BB : 150

QUESTION 4

ANSWER= TRAFFIC CATEGORY 5

QUESTION 5

Answer = 94.56



ANSWER

JUNCTION DESIGN

Exercise 1

Time phase 1 -
Green time = 10 s
amber time = 3 s
Red time = 18 s

Phase 2 -
Red time 1 = 15 s
Amber time = 3 s
Green time = 11 s
Red time 2 = 2s

Exercise 2

Time phase 1
Green time = 25 s
Amber time = 3 s
Red time = 47 s

Time phase 2
Red time 1 = 41 s
Amber time = 3 s
Green time = 31 s

Exercise 3

Time phase 1
Green time = 34 s
Amber time = 3 s
Red time = 50 s

Time phase 2
Red time 1 = 43 s
Amber time = 3 s
Green time = 41 s

Exercise 4

Time phase 1
Green time = 32 s
Amber time = 2 s
Red time = 48 s

Time phase 2
Red time 1 = 41 s
Amber time = 2 s
Green time = 39 s

Exercise 5

Time phase 1
Green time = 10.24 s
Amber time = 3 s
Red time = 17.76 s

Time phase 2
Red time 1 = 17.24 s
Amber time = 3 s
Green time = 10.76 s

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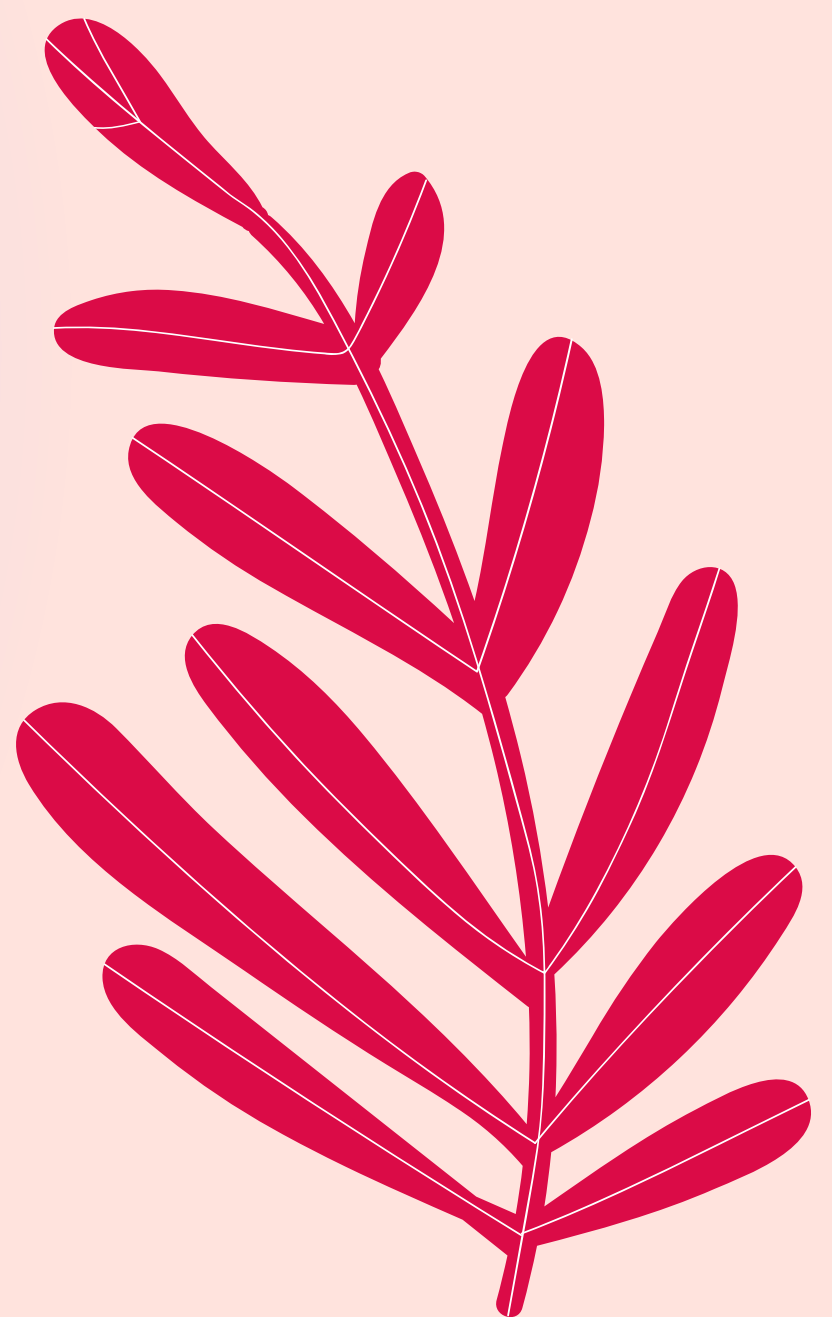
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THANK YOU
VERY MUCH





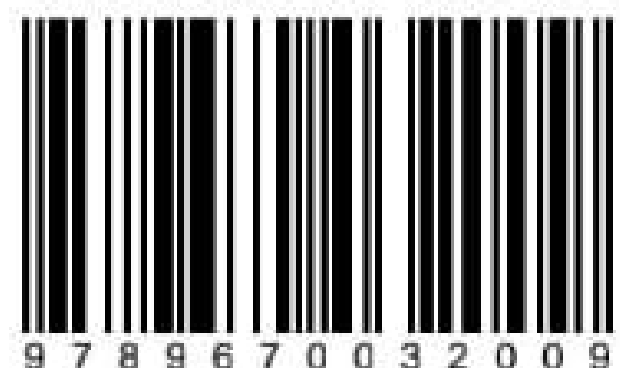
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