Civilittee

اللجنة الأكاديمية لقسم الهندسة المدنية

دفتر

هندسة المواصلات

اعداد الطالب

عمر أبو زياد

/groups/Civilittee

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Transportation Engineering and planning

تخطيط وهندسة المواصلات

إعداد الطالب:

عمر زياد فريد ابوزياد

الحمد لله الذي وفقني لاتمام هذا العمل الذي اسأل الله ان يكون علما نافعاً يستفيد منه زملائي ، وتذكروا ان هذا العمل هو جهد بشري ، فإن أصبت فمن الله وان اخطأت فمن نفسي ، وفي حال وجود اي خطأ يرجى التواصل معي وتنبيه الطلاب .

هذا العمل اهداء لدفعه 2014 .... مع تمنياتي للجميع بالتوفيق .

لا تنسوني ووالدي من صالح دعائكم ولا زميلتنا ايمان ابوهره في يارب اغفر لها وارحمها وارزقها الجنة .

* هذه الدوسية لا تغني عن شرح الدكتور *
وانما هي وسيله مساعده فقط

FIRST

Content :

4-Step transportation demand forecasting

- Trip generation
  - Cross-Classification.
  - Rates Based on Activity units.
  - Linear regression
  - Poisson model
- Trip distribution
  - gravity model.
  - Growth Factor model.
    - Fartar
    - Average
- MODAL SPLIT
  - Trip Interchange
  - Logit Models
- Route Choice
  - Minimum time patt
- Book problems and Solution.

4 - Step transportation demand forecasting Process :

1 Trip generation : Determines how many trips each activity will produce or attract.

* لمعرفة عدد الرحلات التي سوف تدخل او تغادر منطقة معينة "فقط العدد بغض النظر عن المكان او الوسيلة المستخدمة".

Trip purposes :

1- Home - based work (HBW) → (school, UNi)
2- Home - based other (HBO) → shopping
3- Non - home based (NHB) → work → shop

A Cross - Classification :

- determine # of trips that begin or end at the home.
- Variable most commonly used are "avg income" & auto ownership, HH size."

- أدق اشي لل HB "Home based" ، بالاضافة جانب غالباً يستخدم لايجاد ال trip production ⇒ مهم

** سؤال سنوات دائم عن هذه الطريقة : يعطي عدد الاسر وعلاقات بين العدد والمتغيرات على شكل رسمات او جداول (الشائع) و الحل ان ترسمهم على شكل شجرة وتحسب عدد الرحلات لكل نوع.

- التقريب عند اول Trip/HH مهم "تأكد من الكتوره" لاكبر عدد صحيح في حال كان عدد الرحلات *** ليست اعداد صحيحة. (مثال السلايدات).

Ex: Consider a zone that is located in a suburban area of city, with Number of units "HH" = 40
Determain the number of trips per day generated in this zone for each trip purpose?

①

Income ($)	HH (%)
Low	10 %
medium	40 %
high	50 %

②

	Autos / Household		
income	0	1	2+
Low	25 %	25 %	50 %
med.	25 %	25 %	50 %
high	10 %	40 %	50 %

③ Number of Trips per HH

	Autos / HH		
Income	0	1	2+
Low	1	2	4
med.	3	9	7
high	2	12	16

④ trip purpose (%)

	HBW %	HBO %	NHB %
Low	15	55	30
med.	17	51	32
high	18	48	34

Sol :

HH (40)

- Low (10%) → 4
  - 0 (25%): 1×1 → 1
  - 1 (25%): 1×2 → 2
  - 2+ (50%): 2×4 → 8
- Med. (40%) → 16
  - 0 (25%): 4×3 → 12
  - 1 (25%): 4×9 → 36
  - 2+ (50%): 8×7 → 56
- high (50%) → 20 (40 * 0.5)
  - 0 (10%): 2×2 → 4
  - 1 (40%): 8×12 → 96
  - 2+ (50%): 10×16 → 160

Trip / HH → "في حال كان هناك تقريب يتم هنا" (تأكد من الدكتوره)

Low = 11 Trip
- HBW (15%) = 1.65 → $\boxed{2}$
- HBO (55%) = 6.05 → $\boxed{6}$
- NHB (30%) = 3.3 → $\boxed{4}$

med. = 104 Trip
- HBW (17%) = 17.68 → $\boxed{18}$
- HBO (51%) = 53.04 → $\boxed{53}$
- NHB (32%) = 33.28 → $\boxed{34}$

high = 260 Trip
- HBW (18%) = 46.8 → $\boxed{47}$
- HBO (48%) = 124.8 → $\boxed{125}$
- NHB (34%) = 88.4 → $\boxed{89}$

** غالباً في الامتحان تكون اعداد صحيحه الا اذا ....

B Rates Based on Activity Units :

- for calculate attraction . ← تستخدم لحساب

$$\text{Trip att. rate} = \frac{\text{total no. of att. trip / Zone}}{\text{no. of employers}}$$

or

$$\frac{\text{total no. of att trip / Zone}}{\text{Area}}$$

← يعطيك جدول يحتوي على ال Rate بالاضافه لعدد الموظفين او المساحه بالسؤال
- وانت عليك حساب عدد الرحل .

Ex : * Trip Generation Rate

~~HBW~~

	Attraction Per Non retail Employee	Att. Per retail Employee
HBW	1.7	1.7
HBO	2	5
NHB	1	3

and employed at the center are 220 retail and ~~650 non-retail~~ 650 non-retail workers , Determine the number of trips Per day attracted to this Zone :

Sol :

$HBW = (220 * 1.7) + (650 * 1.7) = 1479$

$HBO = (220 * 5) + (650 * 2) = 2400$

$NHB = (220 * 3) + \underline{(650 * 1)} = 1310$

rate att. * no. of employer $= \underline{1 * 650}$

$\boxed{\text{Total} = 5189 \text{ Trips / day}}$

← من أجل الانتقال للخطوه التانيه " Trip distrib. " يجب ان يكون هناك توازن (Balance) بين ال production وال attraction

$\rightarrow \sum \text{trips attraction} = \sum \text{trips production}$

← و يتم عن طريقتين

● How to modified Σ trips att. to equal Σ trip produc.?

① if the trips purpose are HBW or HBO :

- production can't be change لانه من المنزل دائما يمكن احصائها
- the Balance factor :

$$\boxed{f = \frac{\Sigma \text{ production}}{\Sigma \text{attraction}}}$$ * ⇒ multiply with each att.

② if the trips purpose is NHB :

- production and attraction can be considered non reliable
- $\boxed{\frac{\Sigma \text{production}}{\Sigma \text{attraction}}}$ * each attraction = $\boxed{\text{new attractions}}$

⇒ use new att. for both att. & production.

Ex : HBW Trips

Zone	unbalanced HBW Trips production	unbalanced HBW Trips attraction
1	100	240
2	200	400
3	300	160
Total	600	800

balanced HBW Trips production	balanced HBW Trips attraction
100	180
200	300
300	120
600	600

↳ balanced

Case one HBW : $f = \frac{600}{800} = 6/8$

$\frac{6}{8} * 240 = \boxed{180}$, $6/8 * 400 = \boxed{300}$, $6/8 * 160 = \boxed{120}$

⇒ the same ex but the purpose is NHW :

$f = \frac{600}{800} = \boxed{\frac{6}{8}}$ ⟹ * each att. ⇒ new att. = 180, 300, 120

use it for att & production ⇒

Zone	production	attraction
1	180	180
2	300	300
3	200	200
	600	600

balance

** سؤال سنوات "فكرة" :- طلب منا حساب الـ production عن طريق الـ Cross-Classification ومن ثم حساب الـ attraction عن طريق الـ Trip Rates وكان هناك نوعين للرحل الـ HBW والـ NHB وباخر فرع طلب عمل Balance للنوعين في حال احتاجت لـ Balance . (١٢ علامة).

C Linear regression :

- for production and attraction.
- no. of Vehicle-based trips of a given type (shopping or Social.. as a function of various character.

$$\boxed{T_i\ (\text{trip/HH}) = b_0 + b_1 Z_{1i} + b_2 Z_{2i} + \dots b_K Z_{Ki}}$$

Ex :

type	HH size	Annual income, $	no. of non-worker in peak hour	workers departing
1	2	40,000	1	1
2	3	50,000	2	1

There are 100 HH Type 1, 200 HH Type 2 ..... , determine the total no of peak-hour Trips using the following equa.?

** for Vehicle based shopping trips :

no. of Vehicle trips = 0.12 + 0.09(HH size) + 0.011 (annual income/100) − 0.15 (employment in hundreds)

Type 1 : no. of Vehicle = 0.12 + 0.09(2) + 0.011(40) − 0.15(2.05)
= 0.4325 trips/HH * 100 HH = $\boxed{43.25 \text{ trips}}$

تطبيق مباشره على المعادله حسب المتغيرات

Type 2 : 126.5 Trips
" 3 : 240.625 Trips
" 4 : 30.625 Trips

⇒ Total Vehicle-based shopping = $\boxed{441 \text{ trips}}$

في حال لم يكن رقم صحيح تقريبه (التقريب مره وحده على الرقم النهائي)

{work trips = no. of HH * worken no.}

D Poisson model :

- production & attraction
- حل لمشكلة الشهور
- for trip generation (for a given trip type) :

$$\boxed{P(T_i) = \frac{e^{-\lambda_i} \lambda_i^{T_i}}{T_i!}}$$

probability of HH$_i$ making exactly T_i trips. (T_i : عدد صحيح موجب)

$$\boxed{\lambda_i = e^{BZ_i}}$$

HH$_i$ expected number of vehicle-based trips in some specified time period $E[T_i]$.

Ex : given that HH has 6 member, annual income of 50,000, retail employment of 150 and : During shopping-peak hour "equa."

$$BZ_i = -0.35 + 0.03(HH) + 0.004(\text{Annual income}/1000) - 0.1(\text{employment in HH}/100)$$

① what is the expected number of peak-hour shopping trips (λ_i) ?

② what is the probability that the HH will not make a peak-hour shopping trip ? ($P(0)$) ?

Sol :

① $\lambda_i = e^{BZ_i} = e^{-0.35 + 0.03(6) + 0.004(50) - 0.1(1.5)} = e^{-0.12} = \boxed{0.887 \text{ trips}}$

② $P(0) = \frac{e^{-0.887} * 0.887^0}{0!} = \boxed{0.412}$ ← احتمالية الاشخاص الذين لا يقومون بالتسوق خلال فترة الذروة

$P(1) = \frac{e^{-0.887} * 0.887^1}{1!} = \boxed{0.365}$

$P(T_{shopping} > 2) = 1 - [P(0) + P(1) + P(2)]$

"$P(3), P(4), \ldots P(\infty)$"

$P(T_{shopping} \leq 3) = P(0) + P(1) + P(2) + P(3)$

2 Trip distribution : Determine the origin or destination of trips that are generated at a given activity.

← بعد ما حددنا عدد الرحل نحدد ~~[illegible]~~ نقطة البداية والنهاية في هذه الخطوة .

** يشترط ان يكون الـ $\sum production = \sum attraction$.

A gravity model :

* بعطيك جدول الـ attr. والـ produ. و بطلب منك ايجاد الـ

O-D Table → first, second ... iteration
(origin_Destination)

$$** \sum_{i=1}^{n} P_i = \sum_{i=1}^{m} A_i$$

1

i \ j (from O / to D)	1	2	3	P_i
1	T_{11}	T_{12}	T_{13}	P_1
2	T_{21}	T_{22}	T_{23}	P_2
3	T_{31}	T_{32}	T_{33}	P_3
A_j	A_1	A_2	A_3	$\sum P_i$ / $\sum A_j$

* عشان نوقف عل iteration يجب ان يكون ~~[illegible]~~ الـ P_i و A_i متساوي مع given او الفرق بينهم $\leq 5\%$ وإلا دستمر بعمل iteration .

$$T_{ij} = P_i \left[\frac{A_j \, F_{ij} \, K_{ij}}{\sum_{j=1}^{n} A_j \, F_{ij} \, K_{ij}} \right]$$

T_{ij} : no. of trips that are produce in zone i and attracted to zone j

P_i : Total number of trips produce in zone i

A_j : number of trips attracted to zone j

F_{ij} : value which inverse function of travel time

K_{ij} : modify factor هو عبارة عن معامل نتحكم فيه بحيث :-

$K<1$ ① اذا اردت ان تقلل عدد الرحل في حال كانت كثيرة

$K>1$ ② " " " " " " " قليل

$K=0$ ③ " " " " تلغي

⟸ وغالبا الدكتور تعطي قيمته (بالعادة يكون 1) .

P_i & A_j → من جدول الـ produc. & attract)

* لا تنسى التأكد بان $\sum produc. = \sum attra$

** عندما تعمل اول O-D جدول راح يصير عنا Computed A_j, P_i given A_j, P_i → من الجدول المعطى بالسؤال production and attraction

** دائما يجب ان يكون Computed P_i = given P_i وإلا راجع حساباتك

اما بالنسبة للـ attraction فالاختلاف يكون فيها و عليها يحدث التعديل .

** Check and Adjustment : ②

- **difference in Attraction :**

$$\epsilon = \left| \frac{A_{comp} - A_{given}}{A_{given}} \right| * 100\%$$

must be $\leq 5\%$ for all of attrac. or do adjustment.

Ex:

				P_i comp	P_i given
				140	140
				330	330
				280	280
A_j comp	379	210	161	750	750
A_j given	300	270	180	750	750

- لاحظ بالنسبة للproduction فيجب ان يكونو متساويين بالرقم والمجموع
- بالنسبه للattraction فيجب ان يكون متساوي بالمجموع (تأكد منها) و اختلاف بالارقام بين كل اثنين لا يتعدى 5% .
- في حال كانت وحده من الattraction الفرق بينها > 5% مثل 379 & 300 فقط فالتعديل بعمله على كل الـ att. .

- **Adjustment :**

$$A_{jK} = \frac{A_j}{C_{j(K-1)}} A_{j(K-1)}$$

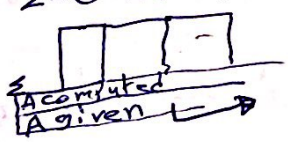
- A_{jK}: adjusted attr. factor for attr. Zone (Column) j, K: iteration
- A_j: (given) desired attraction total for zone (column) j
- $C_{j(K-1)}$: actual (computed) attraction
- $A_{j(K-1)}$: مهم جداً في second iteration هي نفسها الـ given

** التعديل يتم على جميع قيم الـ attraction .

③ Second iteration O-D Table :

- بعتبر القيم A_{12} A_{22} A_{32} اللي حسبتهم من خطوه ② هم الـ given attraction (يعني هم اللي بعوضهم بقانون الـ T_{ij} مكان الـ A_j) بعدين بعمل الـ O-D Table

2-d iteration



الاصليات بالسؤال

- فقط بالقانون
- ~~في حال كان هناك~~
- في حال كان عنا 3 iteration انتبه :- اللي حسبناها بالـ adj تابع الـ second adjustment :

$$A_{13} = \frac{A_1}{C_{12}} A_{12} = \frac{\text{الـ given بالجدول}}{\text{الـ computed بالجدول}} * A_{12}$$

اللي حسبناها بالـ sec. وعوضناها بالقوانين .

8

Ex : Determine the number of Zone-to-Zone trips through two iteration :

Zone	1	2	3	Total
Trip production	140	330	280	750
Trip attraction	300	270	180	750

انتبه يجب ان يكون متساويات، في حال القيم غير متساويه نعدل عليها مثلما اتعلمنا حسب ال Trip purpose في خطوه ال Trip generation .

Friction Factor F_{ij} :

** use $K_{ij} = 1$ for all ⇒ مهم

	1	2	3
1	39	52	50
2	52	26	26
3	50	26	39

Sol : ① O-D Table first iteration :

i \ j	1	2	3	Pi Computed		Pi given
1	47	57	36	140	=	140
2	188	85	57	330	=	330
3	144	68	68	280	=	280
Aj Computed	379	210	161	750		750
Ai given	300	270	180	750		

* لاحظ انه Pi comp. & Pi given نفس المجموع "750" ونفس الارقام
** ال attraction نفس المجموع لكن ارقام مختلفه
* T_{11}, T_{12}, T_{13} الهم نفس المقام لتسهيل الحل .

$$T_{11} = P_1 * \frac{A_1 F_{11}}{A_1 F_{11} + A_2 F_{12} + A_3 F_{13}} = 140 * \frac{300 * 39}{(300 \times 39) + (270 \times 52) + (180 \times 50)} = 47.15 \simeq \boxed{47}$$

$$T_{12} = P_1 * \frac{A_2 F_{12}}{A_1 F_{11} + A_2 F_{12} + A_3 F_{12}} = 140 * \frac{270 * 52}{(300 * 39) + (270 \times 52) + (180 \times 50)} = 56.58 \simeq \boxed{57}$$

التقريب يتم بحيث يكون ال Pi computed = Pi given

② Check and Adjustment : بعمل Check على كل ال attrac. في حال كان فيه وحده > 5% بعدل الكل.

$$\epsilon_1 = \frac{379-300}{300} * 100\% = \boxed{26.3\%} > 5\%$$

⇒ Adjustment :

Zone 1 : $A_{12} = \frac{A_1}{C_{11}} A_{11} = \frac{300}{379} * 300 = \boxed{237}$

** هذه القيم نعتبرها ال A_j بقوانين ال T_{ij} لل O-D Table Second iteration

Zone 2 : $A_{22} = \frac{270}{210} * 270 = \boxed{347}$

Zone 3 : $A_{32} = \frac{180}{161} * 180 = \boxed{201}$

③ O-D Second iteration :

i \ j	1	2	3	P_i computed	P_i given
1	34	68	38	140	140
2	153	112	65	330	330
3	116	88	76	280	280
A_j computed	303	268	179	750	750
A_j given	300	270	180	750	

** لاحظ بأن ال given نفسها الاصليه المعطاه بالسؤال.

** قيم ال A_j التي تم تعويضها بقوانين T_{ij} هي قيم ال Second iteration adjusted.

$$T_{11} = P_1 * \frac{A_1 * F_{11}}{A_1 * F_{11} + A_2 F_{12} + A_3 F_{13}} = 140 * \frac{237 \times 39}{(237 \times 39) + (347 \times 52) + (201 \times 50)} = \boxed{34}$$

** Check : القيم من الجدول دائما

$$\epsilon_1 = \frac{303-300}{300} * 100 = 1\% < 5\% \checkmark$$

$$\epsilon_2 = \left|\frac{268-270}{270}\right| * 100 = 0.741\% < 5\% \checkmark$$

$$\epsilon_3 = 0.56\% < 5\% \checkmark$$

** القيم في ال ϵ بوخذها من الجدول given & computed

[**] For the same previous example assume we need a 3 iteration:

adjustment:

Zone 1: $A_{13} = \frac{A_1}{C_{12}} A_{12} = \frac{300}{303} * 237 = \boxed{234.6}$

(A_1 → given (table); A_{12} → adjusted from 2-d iteration; 237 → انتبه)

Zone 2: $A_{23} = \frac{270}{268} * 347 = \boxed{349.58}$

Zone 3: $A_{33} = \frac{180}{179} * 201 = \boxed{202.12}$

[**] لاحظ: هذه القيم سوف تستخدم كـ A_j في قوانين الـ T_{ij} عند حساب الـ O-D Table 3rd iteration

Ex: OD-Table 3rd iteration:

$$T_{11} = 140 * \frac{234.6 * 39}{(234.6 * 39) + (349.58 * 52) + (202.12 * 50)} = \boxed{34.22}$$

[B] Growth factor models:

- مهم جداً تقرأ وتحفظ فوائده، شروطه، الفرق بينه وبين الـ gravity model (مستوات حفظ).

① Fratar method:

- بعطيك الـ produ. & attra. لمجموعة مناطق + الـ growth factor للرحل مستقبلاً ويطلب الـ O-D Table ①.

$$T_{ij} = (t_i G_i) \frac{t_{ij} G_j}{\sum_x t_{ix} G_x}$$

- T_{ij}: number of trips estimated from Zone i to Zone j
- T_i: future trip generation in Zone i
- t_{ij}: present trips between Zone i and Zone j
- G_j: Growth factor of Zone X
- t_{ix}: number of Trips between Zone i and Zone X.
- t_i: present trip generation in Zone i

- trips generation: تعني

$\sum$ attraction = $\sum$ production = generation trips for Zone.

(other: المناطق الباقية عدا i)

** في جدول ال O-D نقوم بأخذ ال Average يعني نحسب

$T_{AB}, T_{BA} \Longrightarrow \boxed{\overline{T}_{AB} = \frac{T_{AB} + T_{BA}}{2}}$

O-D first estimated :

Zone	1	2	3	estimated Total trip generation	Actual Trip generation
1	$\overline{T}_{12}$			Σ	
2					
3					

** يجب ان يكون ال estimated Total Trip generation = Actual Trip generation

وإلا اعمل adjustment .

② Adjustment :

** New growth factor used in second iteration :

$$\boxed{GA_{new} = \frac{\text{Actual Trips } A}{\text{estimated Total Trips } A}}$$

③ O-D Table second iteration : مهم جداً

* المتغيرات في القانون بوخذها من ال first iteration يعني :-

$$\boxed{T_{ij} = (t_i G_i) * \frac{t_{ij} \; G_j}{\sum_x t_{ix} \; G_x}}$$

G : new growth factor

t_i : estimated Total Trip generation from 1st iteration

t_{ij} : from O-D 1st iteration Table

② Average Growth factor model :

① O-D table first estimated :

$$\boxed{T'_{ij} = T_{ij} \left(\frac{G_i + G_j}{2} \right)}$$

T'_{ij} : estimated future generation trips between i & j

G_i, G_j : growth factor

T_{ij} : Current generation trips between i & j

② Adjustment :

~~estimated~~ Actual future totals = present total * Growth factor

** Actual must be equal to estimated total, if not adjusted

- growth factors to be used in 2nd Iteration :

$$GA = \frac{\text{actual total Trips}}{\text{estimated total Trips}}$$

$$\underset{\text{second iteration}}{T'_{ij}} = T_{ij}(\text{from 1st iteration}) * \left(\frac{G_i + G_j}{2}\right)_{new}$$

Ex : Determine the number of trips between each zone of future condition?

- present trips between zones .

** لازم شرط

Σproduction = Σ attraction

لكل Zone .

Zone	A	B	C	D	Total
A	—	400	100	100	600
B	400	—	300	—	700
C	100	300	—	300	700
D	100	—	300	—	400
Total	600	700	700	400	

- present trip generation and Growth factor :

Zone	Present trip generation (trip/day)	growth factor	Trip Generation in 5 year (actual)
A	600	1.2	720
B	700	1.1	770
C	700	1.4	980
D	400	1.3	520

Sol : O-D first estimated :

Zone	A	B	C	D	Estimated Total Trip generation	Actual Trip generation
A	–	428	141	124	693	720
B	428	–	372	–	800	770
C	141	372	–	430	943	980
D	124	–	430	–	544	520
Total	693	800	943	554		

يجب ان تتساوى القيم
او يكون الفرق < %5
* (تأكد من المعلومة)

$$T_{AB} = (t_A G_A)\frac{t_{AB}\, G_B}{(t_{AB} * G_B)+(t_{AC}\, G_C)+(t_{AD}\, G_D)}$$

$$= (600 * 1.2)\frac{400 * 1.1}{(400 * 1.1)+(100 * 1.4)+(100 * 1.3)} = \boxed{446} \text{ trip/day after 5 yr from now}$$

$$T_{BA} = (t_B G_B)\frac{t_{BA}\, G_A}{(t_{BA} * G_A)+(t_{BC}\, G_C)+(t_{BD}\, G_D)}$$

$$= (700 * 1.1)\frac{400 * 1.2}{(400 * 1.2)+(300 * 1.4)} = \boxed{411}$$

$$\overline{T}_{AB} = \frac{446+411}{2} = \boxed{428}$$

② Adjustment :

$$G_{A\,new} = \frac{720}{693} = 1.039 \simeq \boxed{1.04} \;,\; G_B = \boxed{0.96} \;,\; G_C = \boxed{1.04} \;,\; G_D = \boxed{0.94}$$

③ O-D second iteration :

$$T_{AB} = (t_A G_A)\frac{t_{AB}\, G_B}{(t_{AB}\, G_B)+(t_{AC}\, G_C)+(t_{AD}\, G_D)} = (693 * 1.04)\frac{428 * 0.96}{(428 * 0.96)+(141 * 1.04)+(124 * 0.94)}$$

$$= \boxed{439.31}$$

~~T_{BA}~~ =

$$T_{BA} = (800 * 0.96)\frac{428 * 1.04}{(428 * 1.04)+(372 * 1.04)} = \boxed{410.88}$$

$\boxed{\overline{T}_{AB} \simeq 425}$, $\boxed{\overline{T}_{AC} = 158}$, $\boxed{\overline{T}_{AD} = 121}$, $\boxed{\overline{T}_{BC} = 371}$, $\boxed{\overline{T}_{CD} = 420}$

check it

Ex: using the average growth factor method, calculate the trip distribution for 2 iteration:

Zone	A	B	C	D
A	–	25	50	25
B	25	–	150	75
C	50	150	–	200
D	25	75	200	–
Total	100	250	400	300

• present trips between zones. Table

Zones	present Total	growth factor	Actual future totals
A	100	3	300
B	250	4	1000
C	400	2	800
D	300	1	300

• present trips generation & growth factor

Sol: ① O-D Table first estimated:

	A	B	C	D	T_i'	T_i
A	–	87.5	125	50	262.5	300
B	87.5	–	450	187.5	725	1000
C	125	450	–	300	875	800
D	50	187.5	300	–	537.5	300

T_i' : estimated total
T_i : Actual total

② growth factors to be used in 2nd iteration.

$G_A = \frac{300}{262.5} = \boxed{1.143}$) $G_C = \boxed{0.914}$

$G_B = \boxed{1.379}$) $G_D = \boxed{0.558}$

* First Iteration calculation:

$T_{AB}' = T_{AB}\left(\frac{G_A + G_B}{2}\right)$

$= 25\left(\frac{3+4}{2}\right) = \boxed{87.5}$

③ O-D Table second Iteration:

$T_{AB}' = T_{AB}(\text{from 1st iteration}) * \left(\frac{G_A + G_B}{2}\right)^{new}$

$= 87.5\left(\frac{1.143 + 1.379}{2}\right) = \boxed{110.34}$

$T_{AC}' = 128.56$, $T_{AD}' = 42.53$,

$T_{BC}' = 515.93$, $T_{BD}' = 181.59$

$T_{CD}' = 220.8$

3 MODAL SPLIT: Determine which mode of transportation will be used to make the trip.

- لتحديد الوسيله المستخدمه في الرحلة : سياره ، باص ، تكسي .... الخ .

A Direct Generation of transit trips.

B Trip End models :

- to determine % of person or auto trips that will use a mode.

مشاكله

- prior the trip distribution
- based on Land use & Socieconomic chara.
- doesn't incorporate the quality of service
- only for urban area
- only between 2-mode of transpor.

** Compute the "Urban Travel factor" UTF then use the curve.

⇐ مثال مباشره بالسلايدات .

C Trip Interchange models : ⇐ الافضل

- مهم :- اقرأ النقاط والشرح وقارن بين الطرق .
- يمكن المقارنه بين اكثر من نوعين (باص، سيارة، تكسي)

by using QPS method :

$$MS_a = \frac{I^b_{ij\,t}}{I^b_{ij\,t} + I^b_{ij\,a}} * 100\%$$

نسبه استخدام سياره

$$MS_t = (1 - MS_a) * 100\%$$

** بين نوعين فقط .

MS_a : proportion of trips between i & j using auto

MS_t : " " " " " transit

I_{ijm} : Impedance of travel of mode, m between i & j Zone

$$I = \text{in-Vehicle time (min)} + 2.5 * \text{excess time (min)} + \frac{3 * \text{trip cost}}{\text{income}/120{,}000}$$

(نص رحلة)

* دقيقه عل سنويا

b : depend on trip purpose. (حفظ كابت القانون)

⇐ يوجد مثال تطبيقي بالسلايدات ، المهم التركيز على ال trip cost انها (لنفس رحلة) ، حل المثال وطبق .

D Logit Models :

- used to consider the relative utility of each mode as a summation of each attribute.
- the choise of a mode is expressed as a probability distribution.

$$P(\text{using a spicific mode "A"}) = \frac{e^{U_A}}{e^{U_A} + e^{U_T}}$$

if we have A & T mode.

** سؤال الامتحان يعطي معادلة UA يتم حسابها ومن ثم حساب ال P .

Ex: مثال السلايدات

$U_A = -9.70$

$U_B = -2.97$ (موجودة خطأ بالسلايدات تأكد)

$P_A = 0.00193$

$P_T = 0.99$

4 Route Choice : Determine which route in transportation system will be used to make a trip.

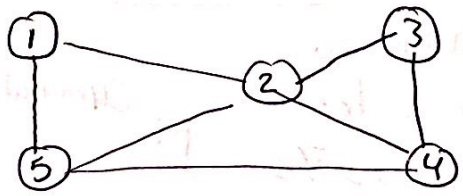
A Diversion Curve : only for 2 route between zone

B Minimum time path "all or nothing"

C ~ ~ ~ with capacity restraint

**مهم :- اقرأ كل طريقة و احفظ النقاط والشرح والفرق بينهم

** مصطلح ال Skim tree مهم معرفة ما هو .



** طريقة الحل :- من جدول ال O-D المعطى بالسؤال :

① assignment of trips :

Nodes		~~min~~ Link Path اقصر مسار	min Travel Path	Volume (OD Table) (بوخذها من ال)
From	to			
1	2	1-2	8	100
	3	1-2, 2-3	11	100
	4	1-5, 5-4	11	200
	5	1-5	5	150

اقصر اشي

O-D Table

② assigned Volume to each Link :

Link	Volume	route taken	Vol calc.	Volume Cumulative
1-2	200	1-2 1-2, 2-3	100 100	100 + 100 = 200
2-1	600	~~1-2, 2-3~~ 2-1 3-2, 2-1	400 200	400 + 200 = 600
1-5	350			
5-1	450			

عدد المسارات رايح جاي ؟

** بحسب ال Volume من جدول رقم ① Cumulitive

③ total Vehicle-min of travel :

Link	Volume	Travel Time	Veh-min of travel
1-2	200	8	1600
2-1	600	8	4800

= Volume * Travel time

** بوخذ ال Link + Volume من جدول ② وبضيف عليهم Travel time للشارع الواحد من الرسم + Veh-min of travel

④ Traffic assigned to nodes : "assigned to node 1" يعني تنتهي بالنود 1

node	Volume assigned
1	600 + 450 = 1050
2	200 + 300 + 250 = 750

Cumulative Volume from table ②

⑤ skim tree : من اول جدول بشوف ال Link اللي استخدمتهم وبرسم .

Problems :

12-4

Given: Cross-classification data for the Jeffersonville Transportation Study Area
Develop the family of cross-classification curves
Determine the number of trips produced (by purpose) for a traffic zone containing 500 houses with an average household income of $35,000. (Use high = 55,000; medium = 25,000; low = 15,000.)

** بالنسبة للجداول اللي في الكتاب تم استخدامهم لعمل curves ومن خلال ال curves تم عمل الجداول التي بالاسفل .

(*) غالبا الدكتوره تعطيك الجداول التي بالاسفل بسؤال الامتحان

Number of HH per Level of Income

Income	Percent	HH/Zone	Total HH
Low	11 %	500	55
Medium	75 %	500	375
High	14 %	500	70
Total	**100**		**500**

Percentage of HH Owning x Vehicles

Auto Ownership	Income		
	Low	Medium	High
0	19	3	0
1	68	64	14
2	13	32	58
3+	0	1	28
Total	**100**	**100**	**100**

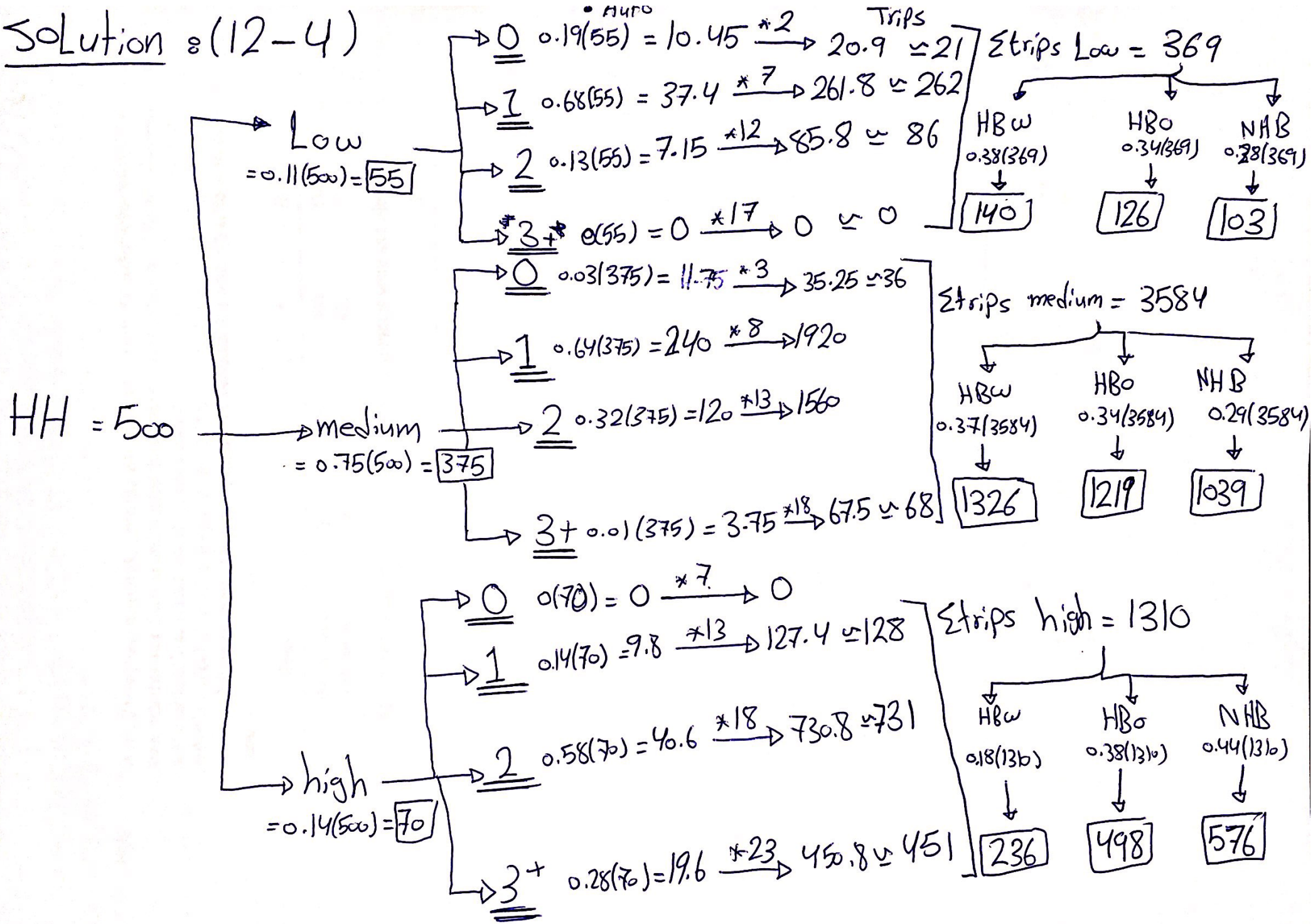
Trips per HH per Income Level and Auto Ownership

Auto Ownership	Income		
	Low	Medium	High
0	2	3	7
1	7	8	13
2	12	13	18
3+	17	18	23

Trips by Purpose (%)

Trip Purpose	Income		
	Low	Medium	High
HBW	38	37	18
HBO	34	34	38
NHB	28	29	44
TOTAL	**100**	**100**	**100**

Solution : (12-4)



12-8 A small town has been divided into three traffic zones. An origin-destination survey was conducted earlier this year and yielded the number of trips between each zone as shown in the table below. Travel times between zones were also determined. Provide a trip distribution calculation using the gravity model for two iterations. Assume $K_{ij} = 1$.

The following table shows the number of productions and attractions in each zone.

Zone	*1*	*2*	*3*	*Total*
Productions	250	450	300	1000
Attractions	395	180	425	1000

The survey's results for the zones' travel time in minutes were as follows.

Zone	*1*	*2*	*3*
1	6	4	2
2	2	8	3
3	1	3	5

The following table shows travel time versus friction factor.

Time (min)	1	2	3	4	5	6	7	8
Friction Factor	82	52	50	41	39	26	20	13

12-10 The following table shows the productions and attractions used in the first iteration of a trip distribution procedure and the productions and attractions that resulted. Determine the number of productions and attractions that should be used for each zone in the second iteration.

	1	*2*	*3*	*4*
P	100	200	400	600
A	300	100	200	700
P^1	100	200	400	600
A^1	250	150	300	600

Solution : (12 - 8)

Iteration 1 :

$$T_{11} = P_1 \left[\frac{A_1 F_{11} K_{11}}{\sum (A_1 F_{11} K_{11}) + (A_2 F_{12} K_{12}) + (A_3 F_{13} K_{13})} \right] = 250 * \frac{395 * 25}{(395*26)+(180*41)+(452*5}$$

$$= \boxed{65}$$

$$T_{12} = 250 * \frac{(180 \times 41)}{(395*26)+(180*41)+(425*52)} = \boxed{46}$$

$$T_{13} = 250 * \frac{(425 * 52)}{(395*26)+(180*41)+(425*52)} = \boxed{139}$$

$\Rightarrow T_{21} = \boxed{209}$ / $T_{22} = \boxed{24}$ / $T_{23} = \boxed{217}$ / $T_{31} = \boxed{168}$ / $T_{32} = \boxed{46}$ / $T_{33} = \boxed{86}$

- Trip Matrix for Iteration 1 :

i \ j	1	2	3	Computed(P)	given (P)
1	65	46	139	250	250
2	209	24	217	450	450
3	168	46	86	300	300
Computed(A)	442	116	442	1000	1000
given(A)	395	180	425	1000	

$$\epsilon = \left| \frac{A_{comp.} - A_{given}}{A_{given}} \right| * 100\%$$

$$= \left| \frac{442 - 395}{395} \right| * 100\% =$$

$$= 11.9\% > 5\% \quad \times$$

Second Iteration :

* Adjustment :-

$$A_{12} = \frac{A_1}{C_{11}} A_{11} = \frac{395}{442} * 395 = \boxed{353}$$

$$A_{22} = \frac{180}{116} * 180 = \boxed{279}$$

$$A_{32} = \frac{425}{442} * 425 = \boxed{409}$$

- Sample of calculation :-

$$T_{11} = 250 * \frac{(353 * 26)}{(353*26)+(279*41)+(409*52)}$$

$$= \boxed{55}$$

$$T_{12} = 250 * \frac{(279 * 41)}{(353*26)+(279*41)+(409*52)}$$

$$= \boxed{68}$$

$\Rightarrow T_{13} = 127 \,/\, T_{21} = 195 \,/\, T_{22} = 38 \,/\, T_{23} = 217 \,/\, T_{31} = 148$

$T_{32} = 71 \,/\, T_{33} = 81$

- Trip Matrix for Iteration 2 :

i \ j	1	2	3	Computed (P)	given (P)
1	55	68	127	250	250
2	195	38	217	450	450
3	148	71	81	300	300
Computed (A)	398	177	425	1000	1000
given (A)	395	180	425		

* Check :

$$E_1 = \left|\frac{398-395}{395}\right| * 100\% = 0.76\% < 5\% \checkmark$$

$$E_2 = \left|\frac{177-180}{180}\right| * 100\% = 1.66\% < 5\% \checkmark$$

$$E_3 = 0\% < 5\% \checkmark$$

Solution : (12 - 10)

- Second Iteration :

- Adjustment : $A_{jk} = \frac{A_j}{C_j(k-1)} * A_j(k-1)$; $k=2$

$A_{12} = \left(\frac{300}{250}\right) * 300 = \boxed{360}$

$A_{22} = \left(\frac{100}{150}\right) * 100 = \boxed{67}$

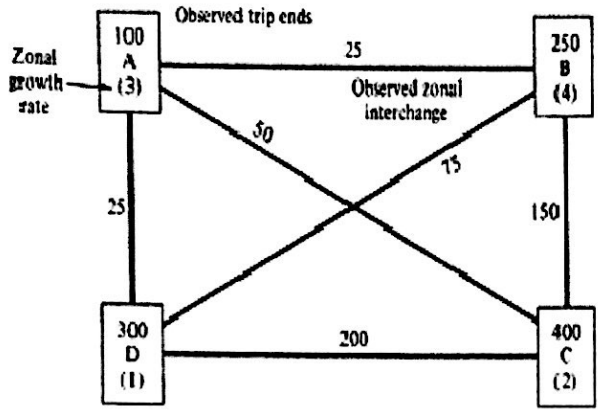
$A_{32} = \left(\frac{200}{300}\right) * 200 = \boxed{133}$

$A_{42} = \left(\frac{700}{600}\right) * 700 = \boxed{817}$

- The attractions change with each iteration ; there is no change in productions.

	1	2	3	4
P^2	100	200	400	600
A^2	360	67	133	817

12-12 For the travel pattern in Figure 12.18, develop the Fratar method of trip distribution for two iterations.



gure 12.18 Travel Pattern

First Iteration

Zones	Present Totals	Growth Factor	~~Estimated~~ actual Future Totals
A	100	3	300
B	250	4	1,000
C	400	2	800
D	300	1	300

12-18 Determine the share (proportion) of person-trips by each of two modes (private auto and mass transit) using the multinomial logit model and given the following information:

Utility function: $U_k = A_k - 0.05\,T_a - 0.04\,T_w - 0.03\,T_r - 0.014\,C$

Parameter	*Private Auto*	*Mass Transit*
T_a = access time (min.)	5	10
T_w = waiting time (min.)	0	15
T_r = riding time (min.)	25	40
C = out-of-pocket cost (cents)	150	100
Calibration constant, A_k	−0.01	−0.07

Solution : (12 - 12)

* Fartar ; 2-iteration : $\boxed{T_{ij} = (t_i G_i) * \frac{t_{ij} G_j}{\sum t_{ix} G_x}}$

Zone	A	B	C	D	Total	Groth Factor
A	–	25	50	25	100	3
B	25	–	150	75	250	4
C	50	150	–	200	400	2
D	25	75	200	–	300	1

* الجدول من الرسمة الموجوده بالكتاب Figure 12.18

1st itration :

$$T_{AB} = (t_A G_A) * \frac{t_{AB} G_B}{(t_{AB} G_B + t_{AC} G_C + t_{AD} G_D)} = (100*3) * \frac{(25*4)}{(25*4)+(50*2)+(25*1)} = \boxed{133.33}$$

$$T_{BA} = (t_B G_B) * \frac{t_{BA} G_A}{(t_{BA} G_A)+(t_{BC} G_C)+(t_{BD} G_D)} = (250*4) * \frac{(25*3)}{(25*3)+(150*2)+(75*1)} = \boxed{166.67}$$

$$\overline{T_{AB}} = \frac{166.67+133.33}{2} = \boxed{150}$$

$T_{AC} = \boxed{133.33}$, $T_{CA} = \boxed{126.32}$ → $\overline{T_{AC}} = \boxed{129.83}$

$T_{AD} = \boxed{33.33}$, $T_{DA} = \boxed{29.03}$ → $\overline{T_{AD}} = \boxed{31.18}$

$T_{BC} = \boxed{666.67}$, $T_{CB} = \boxed{505.26}$ → $\overline{T_{BC}} = \boxed{585.96}$

$T_{BD} = \boxed{166.67}$, $T_{DB} = \boxed{166.13}$ → $\overline{T_{BD}} = \boxed{141.4}$

$T_{CD} = \boxed{168.42}$, $T_{DC} = \boxed{154.84}$ → $\overline{T_{CD}} = \boxed{161.63}$

Zone	A	B	C	D	Estmateded Trip generation	actual trip generation	New groth factor
A	–	150	129.83	31.18	311.01	300	(300/311.01) = 0.965
B	150	–	585.96	141.4	877.36	1000	(1000/877.36) = 1.14
C	129.83	585.96	–	161.63	877.42	800	0.912
D	31.18	141.4	161.63	–	334.21	300	0.898

for second iteration

⇒ Second iteration :

$$T_{AB} = (t_A G_A) * \frac{(t_{AB} G_B)}{(t_{AB} G_B + t_{AC} G_C + t_{AD} G_D)} = (311.01 * 0.965) * \frac{(150 * 1.14)}{(150*1.14)+(129.83*0.912)+(31.18*0.898)}$$

$$= \boxed{161.68}$$

$T_{AC} = 111.24$

$T_{AD} = 26.47$

$T_{BA} = 179.61$

$T_{BC} = 727.03$

$T_{BD} = 157.54$

أكمل الحل

Solution :(12 - 18)

$$U_A = -0.01 - 0.05(5) - 0.04(0) - 0.03(25) - 0.014(150) = \boxed{-3.11}$$

$$U_T = -0.07 - 0.05(10) - 0.04(15) - 0.03(40) - 0.014(100) = \boxed{-3.77}$$

$$P_A = \frac{e^{U_A}}{e^{U_A} + e^{U_T}} = \frac{e^{-3.11}}{e^{-3.11} + e^{-3.77}} = \boxed{0.6593}$$

$$P_T = \frac{e^{U_T}}{e^{U_A} + e^{U_T}} = \frac{e^{-3.77}}{e^{-3.11} + e^{-3.77}} = \boxed{0.3407}$$

12-19 A mode choice logit model is to be developed based on the following information. A survey of travelers in an area with bus service found the following data:

Model Parameter	*Auto*	*Bus*
X_1, waiting time (min.)	0	10
X_2, travel time (min.)	20	35
X_3, parking time (min.)	5	0
X_4, out-of-pocket cost (cents)	225	100
A_k, calibration constant	−0.33	−0.27

The following utility functions were calibrated based on an observed mode split of 84.9% private auto use and 15.1% bus use.

Utility function: $U_k = A_k - 0.10\,X_1 - 0.13\,X_2 - 0.12\,X_3 - 0.0045\,X_4$

After implementing service improvements to the buses, the mode split changed to 81.6% private auto use and 18.4% bus use. Determine a value for the calibration constant for the bus mode that reflects this shift in mode split.

12-21 Determine the minimum path for nodes 1, 3, and 9 in Figure 12.19. Sketch the final trees.

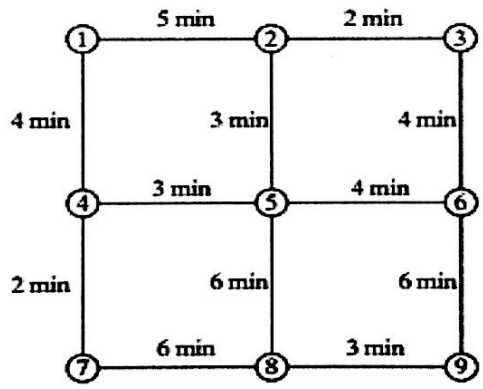


Fig 12 - 19

Solution : (12-19)

$$U_A = -0.33 - 0.1(0) - 0.13(20) - 0.12(5) - 0.0045(225) = \boxed{-4.5425}$$

$$U_b = -0.27 - 0.1(10) - 0.13(35) - 0.12(0) - 0.0045(100) = \boxed{-6.27}$$

** after improvement :

$$P_A = \frac{e^{U_A}}{e^{U_A} + e^{U_b}} = 0.816 \Rightarrow e^{U_A} + e^{U_b} = 0.816 * e^{-4.5425} = \boxed{0.0130475}$$

$$e^{U_b} = 0.0130475 - e^{-4.5425} = \boxed{2.40074 * 10^{-3}}$$

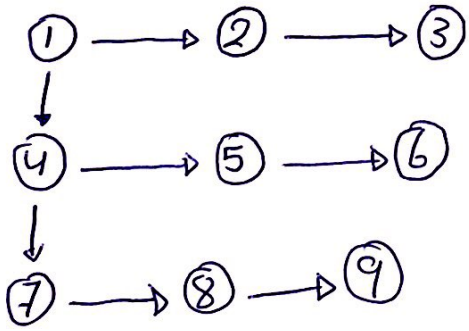
$$\Rightarrow \boxed{U_b = -6.032}$$

$$-6.032 = A_b - 0.1(10) - 0.13(35) - 0.12(0) - 0.0045(100)$$

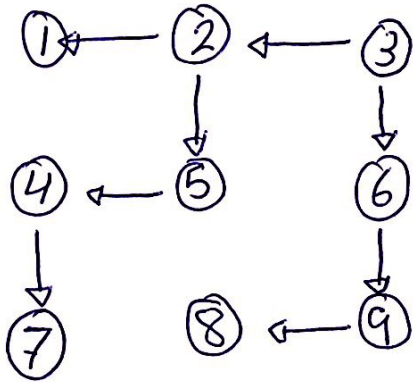
$$\Rightarrow \boxed{A_b = -0.032}$$

Solution : (12-21)

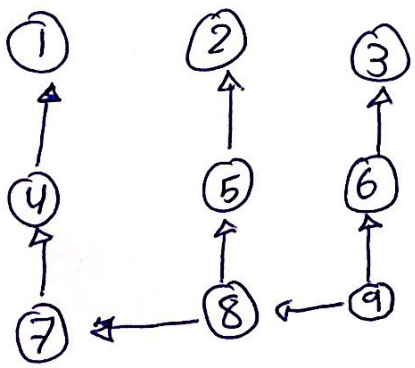
1 :-



3 :-



9 :-



مثال : من ٣ إلى 7

$$\times\ 13_{min} = 7 \xleftarrow{2} 4 \xleftarrow{4} 1 \xleftarrow{5} 2 \xleftarrow{2} 3$$

$$10_{min} = 7 \xleftarrow{2} 4 \xleftarrow{3} 5 \xleftarrow{3} 2 \xleftarrow{2} 3$$

12-22 Assign the vehicle trips shown in the O-D trip table to the network shown in Figure 12.20 using the all-or-nothing assignment technique. Make a list of the links in the network and indicate the volume assigned to each. Calculate the total vehicle minutes of travel. Show the minimum path and assign traffic for each of the five nodes.

	Trips Between Zones				
From/To	*1*	*2*	*3*	*4*	*5*
1	0	100	100	200	150
2	400	0	200	100	500
3	200	100	0	100	150
4	250	150	300	0	400
5	200	100	50	350	0

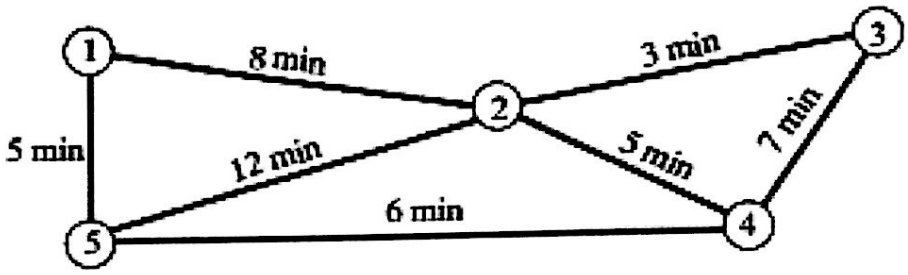


Figure 12.20 Highway Network

Solution : (12-22)

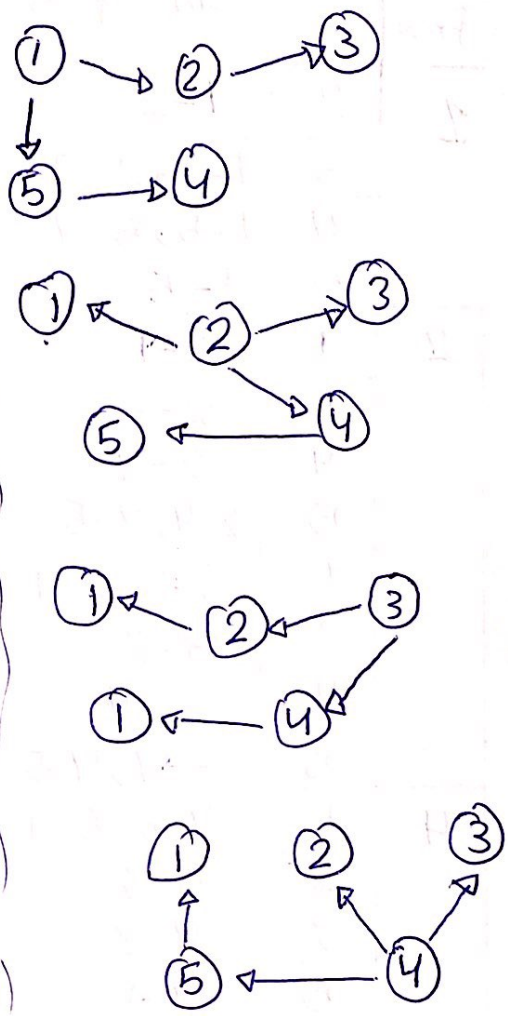
1

Nodes		Link Path	travel time (min)	Volume
From	To			
1	2	1-2	8	100
	3	1-2, 2-3	11	100
	4	1-5, 5-4	11	200
	5	1-5	5	150
2	1	2-1	8	400
	3	2-3	3	200
	4	2-4	5	100
	5	2-4, 4-5	11	500
3	1	3-2, 2-1	11	200
	2	3-2	3	100
	4	3-4	7	100
	5	3-4, 4-5	13	150
4	1	4-5, 5-1	11	250
	2	4-2	5	150
	3	4-3	7	300
	5	4-5	6	400
5	1	5-1	5	200
	2	5-4, 4-2	11	100
	3	5-4, 4-3	13	500
	4	5-4	6	350

2

Link	Volume	travel time	veh-min of travel
1-2	200	8	1600
2-1	600	8	4800
1-5	350	5	1750
5-1	450	5	2250
2-3	300	3	900
3-2	300	3	900
2-4	600	5	3000
4-2	250	5	1250
2-5	0	12	0
5-2	0	12	0
3-4	250	7	1750
4-3	350	7	2450
4-5	1300	6	7800
5-4	700	6	4200
			Σ 32,650

4 Min-Path Trees



3 Assign Traffic

Node	Volume assigned
1	1,050
2	750
3	650
4	1550
5	1650

from Volume in step 2

node 1 → تنتهي في 1

SECOND

Content :

- Route choice
  - User equilibrium
  - by mathematical programing
  - System optimization
- Cash flow
  - Introduction
  - Interest Rate
  - Notation for calculating a present value
  - Basic analysis tools
- Economic Analysis methods
  - present worth analysis
    - Equal - Life Alternative
    - Different - Life Alternative
    - Capitalized cost analysis
  - Annual worth analysis
- Evaluating Transportation Alternative
  - Rating and Ranking

Route choice :

- يتم من خلالها معرفة عدد مستخدمين الطرق بين المناطق وتتألف من ٣ انواع :-

User equilibrium :

- There are two assumption when we use UE : مهم جداً جداً

① travelers will select a route so as to minimize their personal travel time between OD. "origin-destination"

② The travel Time between OD on all used routes is the same and Less or equal to travel time that would be experiened by traveler on any unused route.

1 By equations :

Steps : خطوات حل الاسئلة

1 use performance function to check which route will be used :

* مثال : الوقت المتطلب لقطع طريق رقم ① عندما يكون أزمة = ١٠ دقائق
~ ~ ~ ~ ~ ② وهو فارغ = ١١ دقيقة

← ذلك يعني اننا سوف نستخدم طريق رقم ① ولن يتم استخدام طريق ②.

~~وذلك يتم عن طريق تعويض :-~~

$t_1(q) = 10 \text{ min} < t_2(0) = 11 \text{ min}$

← الحجم المروري

وذلك يتم بتعويض الـ Total Volume والـ 0 بمعادلة زمن الرحلة لكل طريق و المقارنة.

2 assume all travel time for used route is equal.

$t_1 = t_2$, $\boxed{t_1 = 4 + X/C}$ (min)

X : Volume traffic at route 1 (Thousand veh/hr)
C : capacity (Veh/hr)

3 use Conservative of flow :

$X_1 + X_2 + \dots X_n = q$

X_n = traffic vol. (veh/hr)
q = total traffic volume between OD.

$$\boxed{\text{Total travel time (TTT)} = (t_1 \text{ or } = t_2) * q = \square \text{ Veh-min}}$$

$t \Rightarrow min$
$q \Rightarrow Veh$

** if we have before and during reconstruction :
هناك فكرتان في السلايدات :-

1 TTT is constant and q is Variable .

- بحيث يطلب منك حساب حجم الازدحام المتطلب بعد بحيث تحافظ على TTT ثابتة

2 TTT is Variable and q is Constant :

- يطلب حساب التغير الذي سوف يحصل على TTT بعد الانشاء عند ثبات الـ q .

• Note : لما يكون لـ ٣ طرق يجب عمل check ومقارنة بينهم الثلاث .

** X, q : Veh/hr

TTT = Veh-hr or Veh-min مهم ⇐ حسب شو بطلب

Ex1 : المثال الاول بالسلايدات

- اعمل check .

- $t_1 = t_2$ قبل ← مع معادلة الـ $X_1 + X_2 = q$ بتحسب المتغيرات ومن ثم

- $TTT_{befor} = (t_1 \text{ or } t_2) * q = \square$

- لا نستطيع عمل check after لانه ما معنى $q_{(after)}$.

* TTT_{befor} (1) $= TTT_{after}$ ، (2) $t_1 = t_2$ ، $X_1 + X_2 = q_{after}$ (3)

ثلاث معادلات ← ٣ متغيرات

** راجع المثال بالسلايدات .

Ex 2 : $q(\text{fixed}) = 6000$ Vehicles

Befor : $t_1 = 4 + 5\left(\frac{X_1}{4.4}\right)$, $t_2 = 3 + 7\left(\frac{X_2}{5.2}\right)$

After : $t_1 = 4 + 5\left(\frac{X_1}{4.4}\right)$, $t_2 = 3 + 7\left(\frac{X_2}{2.2}\right)$

How many additional vehicle hours of travel time will be added in the corridor assuming UE conditions holds ?

Sol : • befor :

① Check :

$t_1(6) = 10.81$ min
$t_2(0) = 3$ min
$\rightarrow t_1(6) > t_1(0)$ منطقي

$t_1(0) = 4$
$t_2(6) = 11.08$
$\rightarrow t_2(6) > t_1(0)$ منطقي

$\Rightarrow$ route ① & ② will be used.

② $t_1 = t_2 \Rightarrow 4 + \frac{5}{4.4} X_1 = 3 + \frac{7}{5.2} X_2$ and $X_2 = 6 - X_1$

$\Longrightarrow X_1 = 2.85$, $X_2 = 3.15$

$TTT_{befor} = (t_1 \text{ or } t_2) * q = 7.238 * 6000 = \frac{43431.818}{60}$ Veh-min

$= \boxed{723.87 \text{ Veh-h}}$

• after :

- Check

- $t_1 = t_2$, $X_1 + X_2 = q_{after}(6000)$ same

$X_1 = 4.19$, $X_2 = 1.81$

$TTT_{after} = \boxed{875.97 \text{ Veh-h}}$

$\Rightarrow$ reduce the capacity lead to an additional 152.09 Veh-h (875.97 − 723.87) of travel time.

additional examples :

Ex1 : two route connect between (O-D) with flow rate

$q = \underline{15000 \text{ Veh/hr}}$

and $t_1 = 4 + 3X_1$, $t_2 = b + 6X_2$, if the flow on route 1 $\Rightarrow X_1 = \underline{9780 \text{ Veh/hr}}$.

① Determine the free-flow (b) travel time on route 2 ?

② Find TTT ?

■ check is ok ✓

Sol : ~~$X_1 + X$~~ ① $X_1 + X_2 = 15 \Rightarrow X_2 = 15 - 9.78 = \boxed{5.22}$

$t_1 = 4 + 3(9.78) = \boxed{33.34 \text{ min}}$

$t_1 = t_2 \Rightarrow b + 6(5.22) = 33.34 \Rightarrow \boxed{b = 2.02 \text{ min}}$

② $TTT = t_1 * q = \dfrac{33.34 * 15000}{60} = \boxed{8335 \text{ Veh-hr}}$
or t_2

Ex2 : flow rate $q = 3000$ Veh/hr , 3 route :

$t_1 = 8 + 0.5X_1$, $t_2 = 1 + 2X_2$, $t_3 = 3 + 0.75X_3$

Sol : ① check if all route are used :

$t_1(3) = 9.5$ min
$t_2(0) = 1$ min
$t_3(0) = 3$ min

$t_1(3) > t_2(0) > t_3(0)$
it ok ✓ منطقي

$t_1(0) = 8$ min
$t_2(3) = 7$ min
$t_3(0) = 3$ min

$t_1(0) > t_2(3) \Rightarrow$ route ① will never used.

الفرضية UE تفترض انه كل شخص راح يختار الطريق الي بحقق اقل وقت للرحلة
0 حجم مروري ① وقته اكبر من طريق ② وهو ازمه لذلك

$t_1(0) = 8$ min
$t_2(0) = 1$ min
$t_3(3) = 2.5$ min

$t_3(3) > t_2(0)$ ✓ ok
$t_1(0) > t_3(3)$ ✗

So route ② & ③ will be used.

$X_2 + X_3 = 3$ —— ① , $t_2 = t_3$ —— ②

$X_2 = 1.545$
$X_3 = 1.455$

2 by mathematical programing Approch to UE :

- اقرأ الشرح .

$$\boxed{\text{Min } S(x) = \sum_{n} \int_{0}^{X_n} t_n(\omega)\, d\omega}$$

■ Constraints of the function :

1) the flow on all routes ≥ 0 "$X_n \geq 0$".

2) flow conservation holds : $q = X_1 + X_2 \cdots X_n$.

■ Steps :

① Check the performance funce. & route to be used.

② use $q = \sum X_n$. واعمل متغير بدلاله الاخر

③ find :

$$\min S(x) = \sum \int_{0}^{\sum X_n} t_n(\omega)\, d\omega = \int_{0}^{X_1} + \int_{0}^{X_2} = \int_{0}^{q-X_2} + \int_{0}^{X_2} \rightarrow$$ متغير واحد

④ due to $\underline{\underline{\min}}$ $S(x)$

take the 1st derivation for $\min S(x)$

$$\frac{d\, S(x)}{d X_2} = 0 \longrightarrow \text{find } X_2, X_1, t_2, t_1$$

[*] assume the time of travel for all routes used is same.

System Optimization :

3

- منطقي و واقعي اكثر
- يفترض بان الوقت غير متساوي لجميع الطرق
- يحسن من وقت النظام ككل.

** مهم جداً قراءه المعلومات عنه ومعرفة الفرق بينه وبين ال UE.

$$\boxed{\min S(x) = \sum_n X_n \, t_n(X_n)}$$

■ Constraints :

1) $q = \sum_n X_n$

2) $X_n \geq 0$

■ Steps :

① Check PFs

② $q = \sum_n X_n$, $X_1 = q - X_2$

③ $\min S(x) = X_1(t_1(X_1)) + X_2(t_2(X_2))$. بتخليها بمتغير واحد ومن ثم ...

④ $\frac{ds(X_1)}{dX_1} = 0 \longrightarrow X_1 = \square$, $X_2 = \square$

calculate t_1 & t_2.

** انتبه مهم : $t_1 \neq t_2$

■ note :

$$TTT_{UE} = \frac{t * q}{60} \text{ (veh-h)}$$

$$TTT_{S.opt} = \frac{t_1 X_1 + t_2 X_2}{60} \text{ (veh-h)}$$

** يجب ان تكون $TTT_{S.opt}$ اقل من TTT_{UE}.

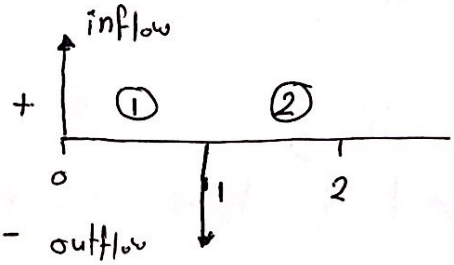
Cash flow :

- Categories of cash flows :

1- inflow : income , saving , savage value , receipts , withdraw

2- outflow : first cost , operation & maintenance cost , savage cost , expenses , deposit

- CFD :



Net cash flow = cash inflow − cash outflow

NCF = R − D

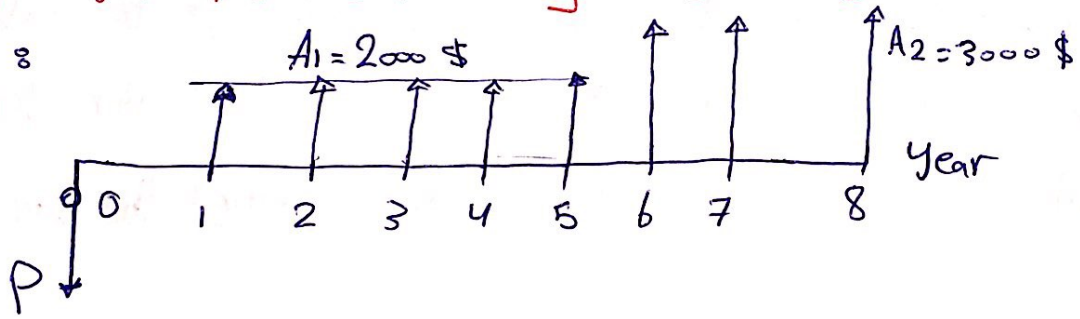
R ← Recipt

D ← disburcement

+ : profit ربح , − : Loss خسارة

Ex : an electrical engineer want to deposit (−) an amout P now such that she can withdraw (+) an equal annual amount of A_1 2000 $ per year for first 5 years , starting 1 year after the deposit , and a different annual withdraw of A_2 $3000 per year for the following 3 years . draw the CFD ?

Sol :



- intrest :

[1] intrest paid : between Bank and man (borrower) .

$$\boxed{\text{interest} = \text{amount owed now} - \text{principle}}$$

principle → "original amount"

$$\boxed{\text{interest rate}(\%) = \frac{\text{interest accrued per time unit}}{\text{principle}} * 100\ \%}$$

"i"

- time unit of rate : interest period

⇒ حل مثال السلايدات مباشرة

2 interest earned : between investor and corrporation.

$$\boxed{\text{interest earned} = \text{total amount now} - \text{principle}}$$

$$\boxed{\text{Rate of return (\%) (RoR) "i"} = \frac{\text{interest accrued per time unit}}{\text{Principle}} * 100\%}$$

Ex : A Company plans to borrow JD 30,000 from a bank for 1 year at 8% interest to buy new equipment. Compute the interest and total amount due to 1 year?

Sol :

$$\text{interest} = 30{,}000 * 0.08 = \boxed{2400 \text{ JD}}$$

$$\text{total amount} = 30{,}000 + 2400 = \boxed{32{,}400 \text{ JD}}$$

Ex :

1. Calculate the amount deposited 1 year ago to have JD 2000 now at an interest rate of 10% per year?
2. Calculate the amount of interest earned during this time period?

Sol :

1. $\text{interest earned} = 2000 - \text{principle}$ $\Rightarrow$ باستخدام القوانين اعلى الصفحه

$$0.1 = \frac{2000 - \text{Principle}}{\text{Principle}}$$

$$\Rightarrow \text{Principle} = \frac{2000}{1.1} = \boxed{1818.182 \text{ JD}}$$

2. $\text{interest earned} = 2000 - 1818.182 = \boxed{181.812 \text{ JD}}$

- inflation and Time Value of money : ⇐ اقرأ السلايدات مهم

- Interest Rate : مهم جداً

- The amount charged, expressed as a percentage of principle, by a Lender to a borrower for the use of assets.

1 Simple interest : اقرأ الشرح مهم

- Linearly proportional to the initial amount of the principal.

- Computation :

$$\boxed{I = P N i}$$

I : interest paid or earned
P : principal
N : number of interest periods
i : interest rate per interest period

* total amount repaid at end of N = $\boxed{P + I}$

- قيمته ثابته كل سنه توخذ نسبه من ال principle .

2 Compound interest : مستخدم بكثره

- Computed on the original unpaid dept & unpaid interest "interest on top of interest".

$$\boxed{I_n = P(1+i)^n - P}$$

I : total interest earned
P : Present sum of money
i : interest rate
n : number of years.

** Future value of Load with compound int.

$$\boxed{F = P(1+i)^n}$$

F : Future Value
P : present Value

** accumulation increase rapidally as time frame increase between simple and Compound due to geometric growth of compount interest.

Ex ①: if 3000 $ were Loaned for 5 year at simple interest rate of 8% per year, the interest earned ?

Sol: $I = PNi = 3000 * 5 * 0.08 = \boxed{1200\ \$}$

Ex 2: using compound interest, if $i = 9\%$, $P = \$100$ and $n = 2$, find F ?

Sol: $F = P(1+i)^n = 100(1+0.09)^2 = \boxed{\$\ 118.81}$

Ex 3: $P = \$100{,}000$, $i = 10\%$ per year, after 3 year

Compare between Simple & Compound interest ?

** مهم جداً معرفة الفرق بينهم مع ذكر مثال و اهم الافعال (سؤال سنوات).

Sol:

Simple interest:

Year 1: 10,000

Year 2: 10,000

Year 3: 10,000

Sum of interest = 30,000

Total amount Paid = 100,000 + 30,000

$= \boxed{130{,}000\ \$}$

Compounded interest:

Interest year 1: 100,000 (0.10) = 10,000 $

Total due, year 1: 100,000 + 10,000 = 110,000 $

interest year 2: 110,000 (0.10) = 11,000 $

Total due, year 2 = 110,000 + 11,000 = 121,000 $

interest year 3 = 121,000 (0.10) = 12100 $

Total due, year 3 = $\boxed{133{,}100\ \$}$

note that the simple interest after 3 year = 30,000

while the Compound interest = 33,100

Notation for Calculating a present Value :

- مجموعه من القوانين يمكن من خلالها التحكم بالقيم على طول CFD و للمقارنه .

$$\boxed{F = P(1+i)^N} \longrightarrow \boxed{P = \frac{F}{(1+i)^N}}$$

- Single payment compound amout factor :

$\boxed{(1+i)^N = (F/P, i, N)}$ → ~~F given~~ F needed , given P at i% per N period

- Single payment present worth factor :

$\boxed{(1+i)^{-N} = (P/F, i, N)}$ → P needed , F given , ...

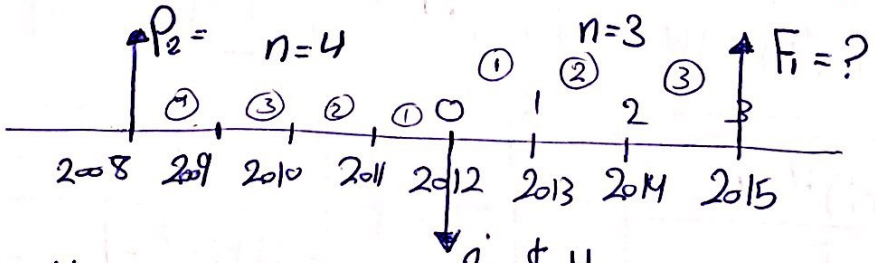
- عند المقارنه ← نحول كل القيم للحاضر (P) ونقارن .
  ← " " " للمستقبل (F) ونقارن .

Ex : A cement factory will require an investment of \$200 million to construct (year 2012) , cost of money is 10% per year as delays required additional .

① The equivalent investment needed if plan is built in 2015 ?

② " " " " been constructed in 2008 ?

Sol :



① $F = P(1+i)^N = 200(1+0.1)^3 = \boxed{\$266.2\ M}$

② $P = \dfrac{F}{(1+i)^N} = \dfrac{200}{(1+0.1)^4} = \boxed{\$136.6\ M}$

Minimum attractive Rate of Return (MARR) : قرأ الشرح السلايدات مهم

- is areasonable RoR established of the evaluation and selection of alternatives.
- RoR < MARR → no accepted "not economically viable"
  RoR ≥ MARR → accepted.

** هو عباره عن عائد ربح مقدر موضوع من خبراء اقتصاديين كنسبه ثابته يجب على اي مشروع يريد دخول المنافسه ان يكون عائد الربح له اكبر او يساوي MARR

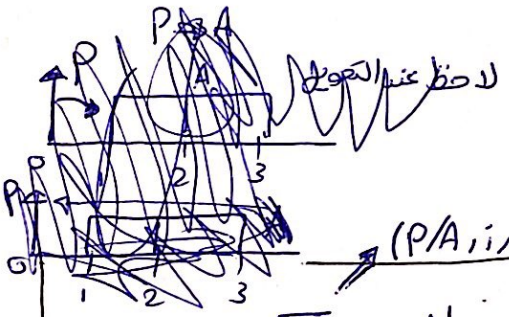
RoR : قيمه العوائد من مشروع معين

MARR : اقل قيمه عوائد مسموح بها لاي مشروع

Annuity : is an amount of money that is paid or gaid annually

اذا لم تحدد السنة دائما تبدأ بنهاية السنه الاولى

Constant payment



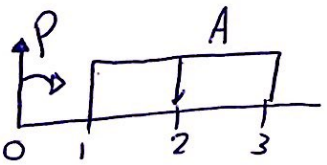
$$P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] \quad (P/A, i, N)$$

$$A = P\left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] \quad (A/P, i, N)$$

$$F = A\left[\frac{(1+i)^N - 1}{i}\right]$$

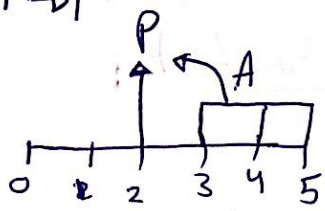
$$A = F\left[\frac{i}{(1+i)^N - 1}\right] \quad (A/F, i, N)$$

⊛ P → A



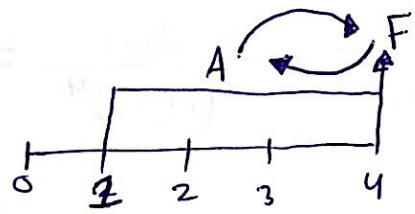
لاحظ عند تحويل ال P لـ A تبدأ اول دفعه بعد سنه من P .

A → P



عند تحويل ال A لـ P تكون ال P قبل بسنه من اول A

F → A or A → F



Last Value of A and F occure at the same time.

Ex: A cement plant may generate a revenue base of \$50 M per year the president of the company may have reason to be quite pleased with this projection for the simple reason that over the 5-year planning horizen, the expected revenue would total \$250 M which is \$50 M more than the initial investment with money worth 10% per year.

- will the initial investment be recovered over the 5-year with time value of money considered?

Sol: the ~~initial~~ initial investment = 200,000,000 \$

and the equivalent present value for A = 50 M\$ at 5 year

$$P = 50\left(\frac{(1+0.1)^5-1}{0.1(1+0.1)^5}\right) = \$\,189{,}540{,}000 \text{ Less than } \$200\text{ M}.$$

So the plant needs to generate

$$A = 200\left(\frac{0.1(1+0.1)^5}{(1+0.1)^5-1}\right) = \$\,52{,}760{,}000 \text{ per year to realize}$$

a 10% per year return over 5 year.

Ex: Acme borrowed \$100,000 from a local bank, which charges them an interest rate of 7% per year, if Acme pays the bank \$8,000 per year, how many years will it take to pay off the loan?

Sol: $P = A\left[\frac{(1+i)^N-1}{i(1+i)^N}\right] \Rightarrow 100{,}000 = 8{,}000\left[\frac{(1.07)^N-1}{0.07(1.07)^N}\right]$

Solved it by calculator $\Rightarrow$ $\boxed{N = 30.7 \text{ years}}$

⟸ حل باقي الامثلة بالسلايدات.

Basic analysis tools :

مهم جداً فهم الانواع وحفظ كل منهم بالسلايدات .

- the nature of the economic proposals :

1. Mutually exclusive alternatives : only one of the proposals can be selected, each viable proposal is called an alternative
2. Independant projects : more than one proposal can be selected each viable proposal is called a project.
3. do-nothing (DN) : alternative or project : an option when the evaluation is performed, and its means that the current approach is maintained.

* هو نفسه المشروع الموجود ، عندما يتم تقييم البدائل والحلول للمشروع ويتبين انه من الافضل الابقاء على المشروع الموجود دون تغيير .

⟹ طريقة المقارنة

1. Mutually exclusive alternatives compete with one another and are compared pairwise.

(*) مهم :- اول اشي قارن كل بديل بال DN بعدين قارنهم مع بعض على شكل ازواج .

2. Independent : are evaluated one at time and compete with DN project only.

Revenue alternative
cost "

⟶ مهم جداً حفظهم من السلايدات

- Pw for DN = 0

Economic Analysis methods :

* مجموعة طرق يمكن من خلالها المقارنة بين البدائل او المشاريع واختيار الافضل اقتصادياً من بينهم .

- مهم جداً شرح السلايدات لكل نوع .

1 Present worth analysis :

- نقوم بتحويل جميع القيم إلى الحاضر "P" ومن ثم المقارنة بناءاً على اساس معينة .

A Equal - Life Alternative :

- all alternative have the same Life (Period).
- all future cash flow are converted to present amount (P) with RoR "MARR".

عند المقارنة

① Mutually exclusive (ME) :

- one alternative : $PW \geq 0$ and $RoR \geq MARR \Rightarrow$ economically justifide
- Two or more alter. : select alternative with ~~largest~~ numeically largest.

+ , + ⟶ الاكبر (الاكثر ربح)

− , − ⟶ الاكبر كسالب (اقل تكلفة او خسارة)

+ , − ⟶ الموجب (ربح) .

② Independent project : each "PW" is considered separatelly and compare with DN ($PW = 0$).

* one or more Independent project : select all with $PW \geq 0$, MARR or more

* They ~~inde~~ must be revenue project :

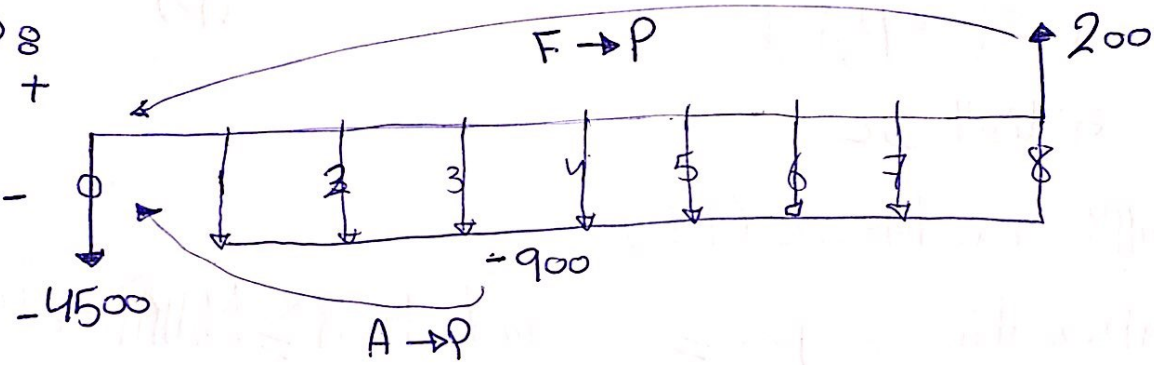
يعني فيها ⊕ و ⊖ cash flow عشان يطلع الـ $PW > 0$.

Ex: MARR = 10 %

	EP	GP	SP
First cost	-4500	-3500	-6000
Annual op. cost	-900	-700	-50
Salvage value	200	350	100
Life, year	8	8	8

Sol: by using present worth analysis convert all future cash flow to present value.

EP:



$$EP = -4500 + -900\left(\frac{(1.1)^8 - 1}{0.1(1.1)^8}\right) + \frac{200}{(1.1)^8} = \boxed{-9208}$$

$$GP = \boxed{-7071}$$

$$SP = \boxed{-6220}$$

all values are negative, to compare between them take the numerically largest.

$\longrightarrow$ EP = $\boxed{-6220}$ $\Longleftarrow$ الاقل تكلفة cost

B Different - Life alternative :

- pw must be compared at <u>same no. of years</u> and <u>end at same time</u> to satisfy equal service requirement.

- اقرأ الشرح مهم جداً .

1 Least common multiple (LCM) : Compare the pw of alter. over a period of time <u>equal Least common multiple</u>.

- نأخذ المعامل المشترك الاصغر للبدائل ونعتبره كفتره ثابته و نحول كل القيم فيها لـ "Pw" ومن ثم نقارن نفس الطرق السابقة .

** عند الحل : - القيم على طول الـ Life cycle of the LCM تتكرر بنفس الطريقة .

- نجد الـ LCM بين البدائل ثم نرسم الـ CFD لكل واحد بحيث كل القيم تكرر نفسها على كل Life cycle ونحسب الـ pw لهم ونقارن .

2 Study period : Compare the pw of alter. using a specified study period on n years.

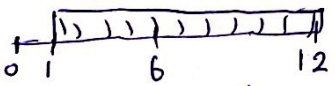
- only cash flow which occure during that time period are considered relevant to analysis (\[redacted])

- نقوم بحساب الـ pw للـ Cash flow estim داخل الـ SA لكل بديل ونقارن.

** ملاحظات :-

① الـ "A" عند حسابها في LCM تحسب على طول الـ LCM مره واحده

LCM = 12



② في حال طلب السؤال الحل على طريقة الـ study area ولم تعطى ، تعتبر اقل Life period بين البدائل هي الـ SA لكل وتحل .

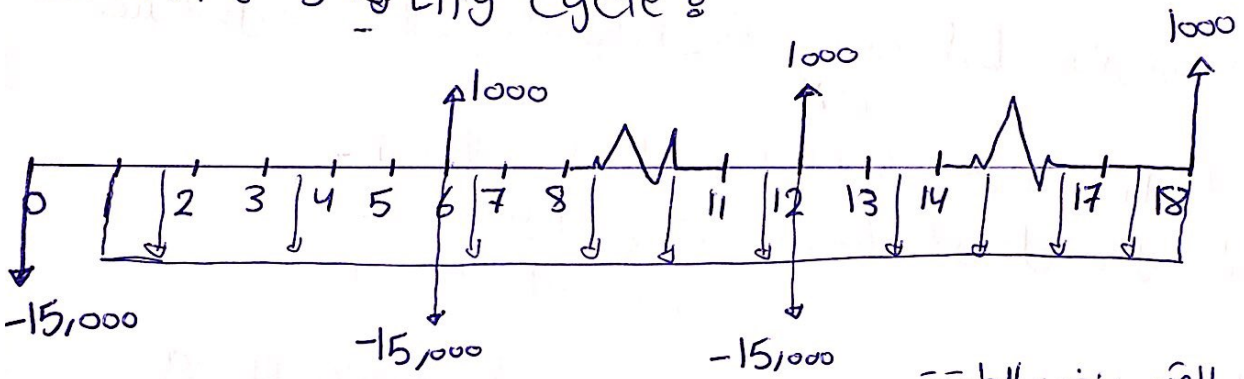
Ex : MARR = 15%

	Vendor A	Vendor B
First cost	-15,000	-18,000
Annual M&O cost $	-3,500	-3,100
Salvage value $	1000	2000
Life, year	6	9

Sol :

① LCM → 6 → 12 → 18 ; 9 → 18 → $\boxed{LCM = 18 \text{ year}}$

Vendor A : 3 Lify Cycle :



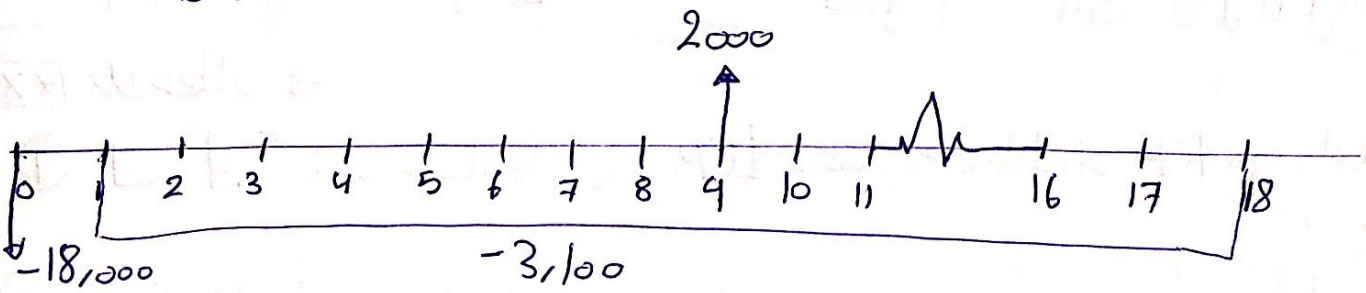
** لاحظ تكرار القيم بنفس الطريقة .

- ال A على طول ال LCM .

$$PWA = -15000 + -3500\left(\frac{(1+0.15)^{18}-1}{0.15(1+0.15)^{18}}\right) + \frac{-15000}{(1+0.15)^{6}} + \frac{-15000}{(1+0.15)^{12}}$$

$$+\frac{1000}{(1+0.15)^{6}} + \frac{1000}{(1+0.15)^{12}} + \frac{1000}{(1+0.15)^{18}} = \boxed{-45,036}\ \$$$

Vendor B :



PWB = $\boxed{-41,384}$ $ ⇒ Select Vendor B ⇐ اقل كلفة

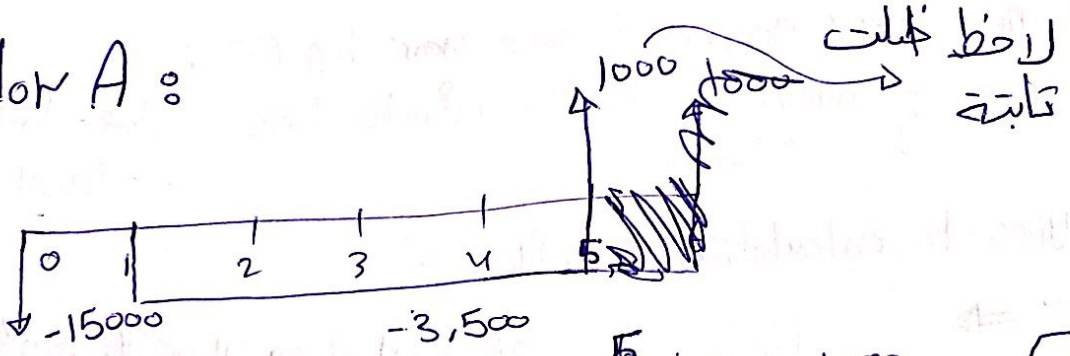
② if a study period of 5 years is used and the Salvage values are not expected to change, which Vendor should be selected ?

مهم

** سوف تتم دراسة المشروعان خلال اول 5 سنين من كل واحد لذلك نستثني اي قيم (Cash flow) خارج هذه الفترة ، مع الاخذ بعين الاعتبار الملاحظة بالسؤال و هي ثبوت الـ Salvage value يعني نحذفها .

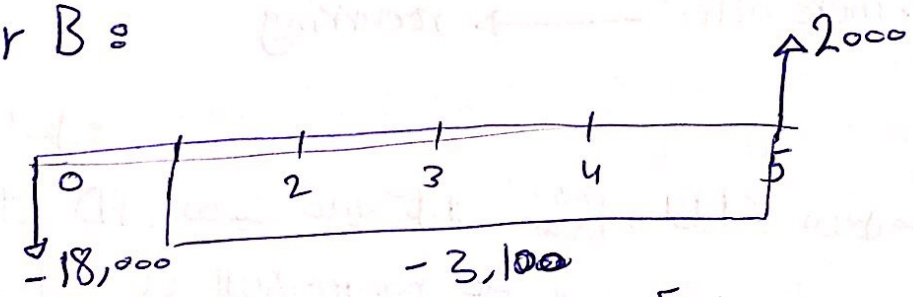
Sol :

Vendor A :



$$pw = -15,000 + -3,500\left(\frac{(1+0.15)^5-1}{0.15(1+0.15)^5}\right) + \frac{1000}{(1+0.15)^5} = \boxed{-26,236}$$

Vendor B :



$$pw = -18,000 + -3,100\left(\frac{(1+0.15)^5-1}{(0.15)(1+0.15)^5}\right) + \frac{2000}{(1+0.15)^5} = \boxed{-27,397}$$

⇒ select Vendor A ⟹ اقل كلفة

** لاحظ التغير الكبير بحيث في الفرع الاول كانت الـ B افضل .

- اقرأ الملاحظات بعد نهاية هذا المثال مهم جداً (سلايدات) .

C Capitalized Cost Analysis :

- used for bridges, dams, highways, railroads with very long usefull life
- Perpetual or infinite Life (∞) or more the 35 yrs (≥ 35).
- CC is present worth (PW) for project with very long life.

$$\boxed{CC = \frac{A}{i}} \quad \text{or} \quad \boxed{CC = \frac{A_w}{i}}$$

- amount of new money generated each year by CC :

$$\boxed{A_w = CC \; i}$$ annual worth for infinite time "forever"

دفعات بتضل لطول الحياه للمالانهايه .

** two types to calculation cash flow :

1. recurring ⇒ تتكرر على طول الفترة لـ ∞ او لاخر سنه في حال (≥ 35) .
2. non-recurring ⇒ غير متكرره او تتكرر لعدد معين من السنوات ولكن ليس لـ ∞ او اخر سنة

** every year, there after ⟶ recurring

** طريقة الحل :-

1. ارسم الـ CFD بحيث عليه كل الـ non recur و اقل اشي دورتين من الـ rec. .
2. احسب الـ CC للـ non-recurring على القوانين القديمة .
3. اوجد الـ "A" لدوره حياه واحده لكل الـ recurring و احسب الـ CC الها عن طريق القانون الجديد

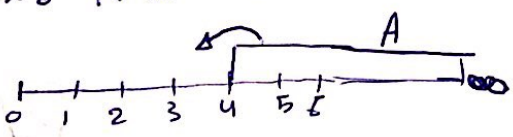
** ملاحظات :-

① ممكن نجمع كل قيم الـ "A" المستمره من الـ ∞ واسميها A_w واقسمها على i

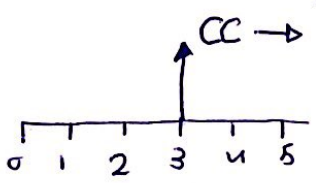
② مهم : لم اقسم $CC = \frac{A}{i}$ بتصير عباره عن (single value) وبترجع سنه للخلف.

لاحظ رجعت سنه للخلف وصارت عباره عن single value زي كانها (P) .

Ex: A is continuous from 4 years → ∞



$CC = \frac{A}{i}$ ⇒

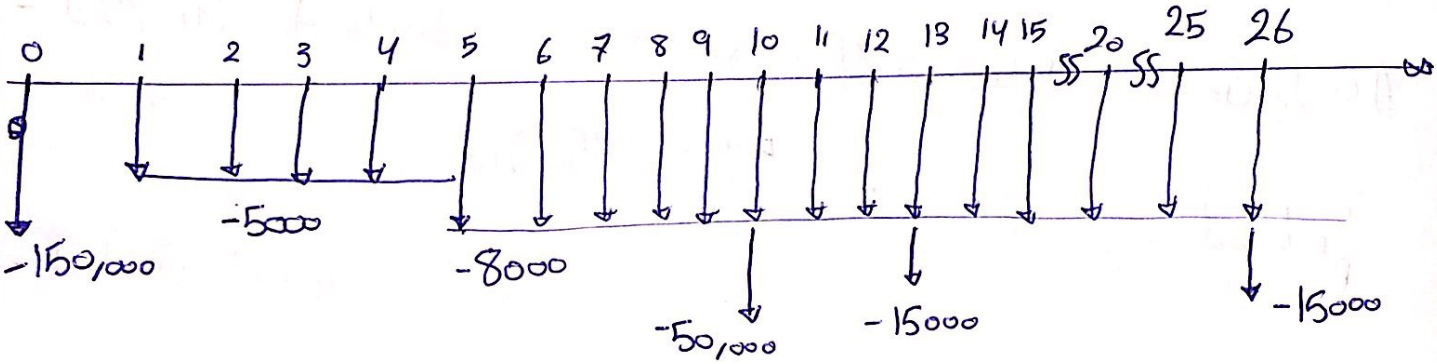


Ex: حل مثال السلايدات بطريقة مختلفة

- the system has an installed cost of $150,000 and an additional cost of $50,000 after 10 year.
- The annual software maintenance contract cost is $5000 for the first 4 years and $8000 therafter
- recurring major upgrade cost of $15,000 every 13 year
- i = 5%

اقرأ الملاحظات في نهاية السؤال بالسلايدات

Sol:



** بدي افرض انه ال 5000 هي عباره عن non-recurring على 4 سنين بحولها عادي A ← P
وال 8000 عباره عن recurring بحولها ل CC بترجع لسنه 4 بعدين بحولها ل F ← P.

Sol:

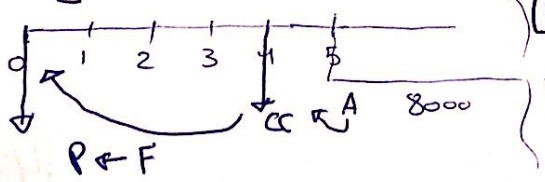
$$CC_1 = 5000 * \left(\frac{(1.05)^4 - 1}{0.05(1.05)^4}\right) = \boxed{17729.753\ \$}$$

$$CC_2 = 50000/(1.05)^{10} = \boxed{30695.663\ \$}$$

$$CC_3 = \left[15000 * \left(\frac{0.05}{(1.05)^{13} - 1}\right)\right] / 0.05 = \boxed{16936.73\ \$}$$

حولت ال non-recur. Value ل A على one life cycle بعدين حولت ال A ل CC

$$CC_4 = \frac{8000}{0.05} = 160000 / (1+0.5)^4 = \boxed{131632.396\ \$}$$



$$\boxed{CC_T = 346,995\ \$}$$

$$\Rightarrow A_{\infty}\ forever = CC_T * i = \boxed{17,350\ \$}$$

دفعات سنوية لل ∞ .

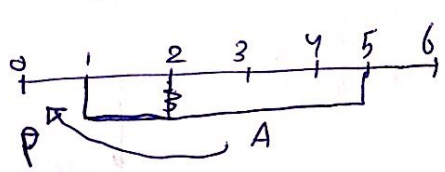
2 Annual worth analysis :

- Aw value is the equivalent uniform annual for all estimated Cash flow during Life Cycle of the alternative.

$$\boxed{A_w = P_w(A/P, i, n) = F_w(A/F, i, n)}$$

- افضل طريقة لانه لا نحتاج لتوحيد المستوات او اخذ عامل مشترك للمقارنه.
- نحول كل القيم لـ P او F ومن ثم نحولها لـ A على كامل حياه المشروع (n).
- لا نحتاج لاستخدام LCM لانه الـ A لـ one Life cycle هي نفسها على كل الـ Future Life cycle (LCM).
- لازم تكون A على طول فترة حياه المشروع ، وإلا بنحولها لـ Pw ومن ثم لـ Aw

مثال :-



$\rightarrow A \xrightarrow{5yr} P \xrightarrow{6yr} A_w$

- اقرأ شرح السلايدات :) .

المقارنه

① one alter. : $A_w \geq 0$, $ROR \geq MARR$ → economacly satisfied

② Two or more alt. :

+ , + → الاكبر

− , − → الاكبر كـ سالب (اقل كلفة)

+ , − → الـ (+)

- Independent : $A_w \geq 0$, $MARR \leq ROR$ → Select all.

** Aw for one Life cycle = Aw for LCM **

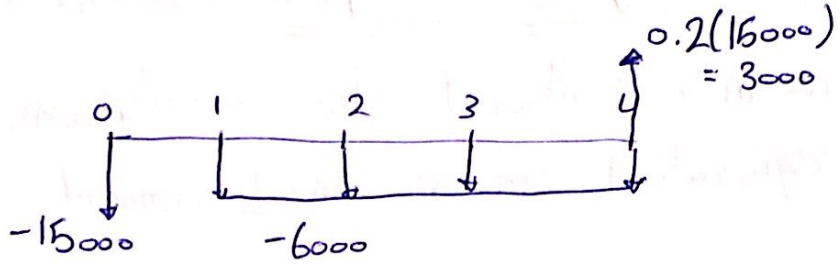
Ex: MARR = 8%

	Hamilton (H)	infinity care (C)
initial cost P $	-15000	-20,000
annual O&M	-6000	-9000
Refurbishment	0	-2000 every 4 year
Trade-in value % of P	20%	40%
Life years	4	12

ملاحظة من الدكتوره
انه ما حدا بجدد وبيع
لذلك هذه القيمة
لا تتكرر على اخر سنة

Sol:

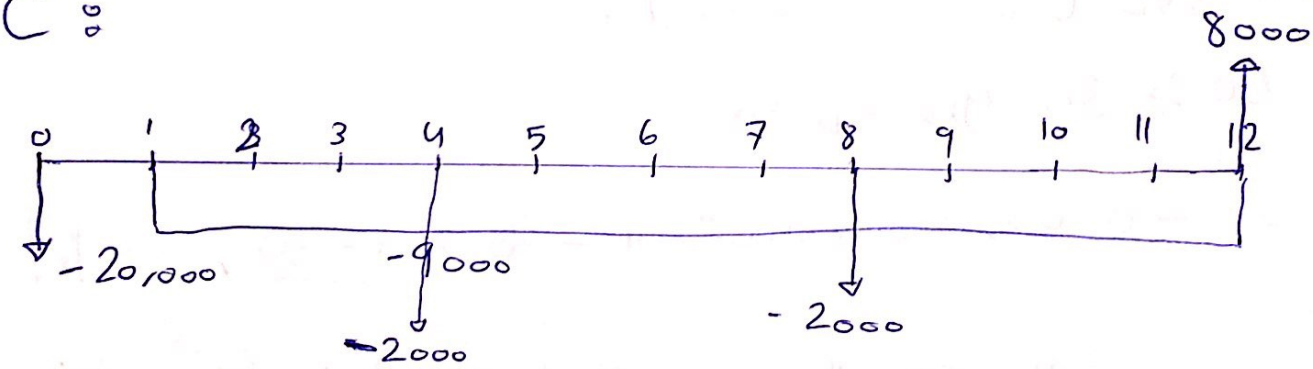
H:



$$P_w = -15000 + -6000 \left(\frac{(1.08)^4 - 1}{0.08(1.08)^4}\right) + \frac{3000}{(1.08)^4} = -32667.6715\ \$$$

$$A_w = -32667.6715 * \left(\frac{0.08(1.08)^4}{(1.08)^4 - 1}\right) = \boxed{-9863\ \$}$$

C:



$$A_w = \boxed{-11,571\ \$}$$

⇒ select the Hamilton "Lowest cost".

Aw of a Permanent Investment :

- infinite or $\geq$ 35 years
- Aw of initial investment :

$$\boxed{A = P\,i = (CC)\,i}$$

- Cash flow recurring at regular or irregular intervals are handled exactly as in conventional Aw computations, convert them to equivalent unifor annual amount A for one cycle.

$\Longrightarrow$ this automatically annualizes them for each succeding life cycle.

Ex :

Proposal C : محلول خطأ

$50 \geq 35$ yrs $\Rightarrow \infty$

$$A = -6000{,}000 * 0.05 + -3000 = \boxed{-303{,}000\ \$}$$

● فكره سنوات ∞ الفرع الاول طلب حساب ال CC لكل مشروع و الفرع الثاني طلب حل بطريقة الـ Aw .

$\Leftarrow$ يمكن حلها مباشره عن طريق

$$\boxed{Aw = CC * i}$$

Evaluating Transportation Alternatives :

Befor Construction :

1 Rating and Ranking :

- in case where criteria values cannot be transformed into monetory amount :

$$S_i = \sum_{j=1}^{N} K_j V_{ij}$$

S_i : total value of score of alternative i
K_j : weight placed on criteria j
V_{ij} : relative value achieved by criterial j for alter. i .

** طريقة السؤال و الحل :-

1 بعطيك جدول يحتوي على MoE لكل alter. لمعايير معينة .

2 جدول يحتوي على ال obj "criterial" وال Rank لكل وحده .

الحل : ① اعمل جدول ←

obj	Rank	w_j	K_j
1	من الاعلى للاقل اهميه	5	
2			
3			
4			
5			

$$K_j = \frac{w_j}{\sum_{j=1}^{n} w_j} \qquad \sum K_j = 100$$

← اعلى وحده اهميه بعطيها عدد ال (obj) بعدين بصير انزل (n-1) كل ما يتغير ال Rank

② اعمل جدول ال $(V_{ij} * K_j)$.

** ال V_{ij} هي عباره عن (من جدول ال MoE 1)

قيمه البديل لل MoE → ☐
اعلى قيمه في ال MoE → ☐
نفسها

ع تأكد من الدكتوره

MoE	I	II	VI
1			
2			
3			
4			
5			

$\sum = S_i$

← اعلى Scoring هو افضل واحد

- في مثال السلايدات قسمنا ال (V_{ij}) على اعلى قيمه لانه طلب انه يكون الاعلى هو الافضل ، في حال كان الاقل هو الافضل نقسم على اقل قيمه

2 Cost effectiveness : من السلايدات

- after construction :

3 evaluation of completed project .

FINAL

Content :

- Circular curves
  - Horizontal curves
  - Suber elevation
  - Vertical curves
- Transite rate
- Service frequency
- Headaway
- Service capacity
- Parking inventory
  - Average parking Duration
  - Turnover rate
- Wind Rose
- Objects Affecting Navigable Airspace
- past papers (اسئلة سنوات)

Circular Curves :

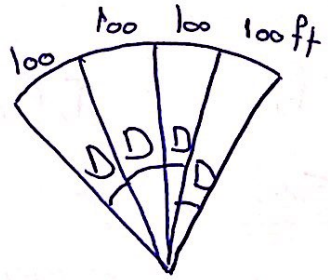
1 arc definition :

- for highway

$$D = \frac{5729.58}{R} \text{ ft}$$

$$\frac{2\pi R}{360} = \frac{100}{D}$$

$$D = \frac{1718.87}{R} \text{ m}$$



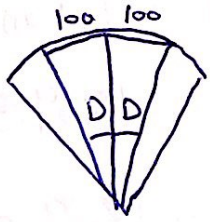
D : degree of curveture

2 Chord definition :

- for rail road

$$\sin\left(\tfrac{1}{2}D\right) = \frac{50}{R} \text{ ft}$$

$$\sin\left(\tfrac{1}{2}D\right) = \frac{15}{R} \text{ m}$$



Layout of simple Horizontal Curve :

$$T = PI - BC = EC - PI$$

$$L = EC - BC$$

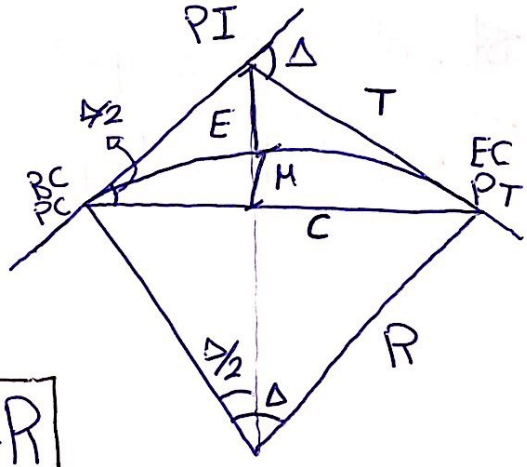
$$T = R \tan(\Delta/2)$$

$$C = 2R \sin(\Delta/2)$$

$$E = R \sec(\Delta/2) - R$$

$$M = R - R \cos(\Delta/2)$$

$$L = \frac{R \Delta \pi}{180}$$



Curvature : (Dc)

flate curve → 1° - 3°

sharp " → 8° - 10°

> 10° → seldon used

16° - 20° → mountainous area or Low speed approach

40° → rail road yards

سنوات اكل
فواغ

Ex: Simple curve: $\Delta = 30^\circ 24' 11''$, $D = 3^\circ 10'$

full station = 100 ft, st of PI = 25+00

find: R, T, E, Lc, M, L, st. of PC, st. of P.T:

Sol:

$$D = \frac{5729.58}{R} \Rightarrow R = \frac{5729.58}{3^\circ 10'} = \boxed{1809.34 \text{ ft}}$$

$$T = R\tan(\Delta/2) = 1809.34 * \tan\left(\frac{30^\circ 24' 11''}{2}\right) = \boxed{491.64 \text{ ft}}$$

$$E = 1809.34 * \sec\left(\frac{30^\circ 24' 11''}{2}\right) - 1809.34 = \boxed{65.61 \text{ ft}}$$

$$M = 1809.34 - 1809.34 \cos\left(\frac{30^\circ 24' 11''}{2}\right) = \boxed{63.31 \text{ ft}}$$

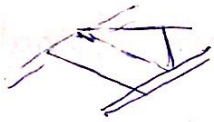
$$L = \frac{1809.34 * 30^\circ 24' 11'' * \pi}{180} = \boxed{960.1 \text{ ft}}$$

st. of PC = PI − T = 25+00 − (4+91.64) = 20+08.3

st. of PT = L + PC = 2008.36 + 960.1 = 29+68.46 ft

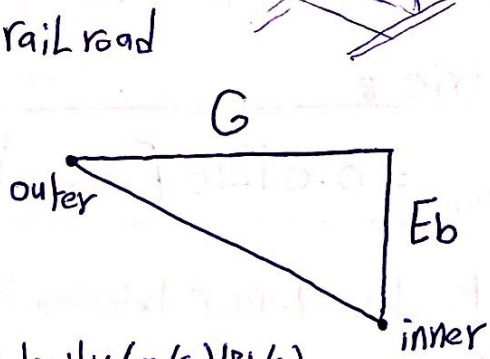
Suber elevation :

1 Balanced elevation :



$$\boxed{E_b \underset{(in,mm)}{=} \frac{G V_d^2}{gR}}$$

ادرس اشتقاق القانون من السلايدات



E_b : balanced elevation (in, mm) . , V : velocity (m/s) (ft/s)

G : Gauge between inner and outer rails (in, mm)

g : rate of gravitional acceleration (32.2 ft/sec², 9.81 m/sec²).

R : radiuse of circular curve (ft, m)

⇒ by using G = 1511 mm (59.5 ft) as standard value :

$$\boxed{E_{b(mm)} = \frac{11.9\ V^2}{R}} \quad , \quad \boxed{E_{b(ft)} = \frac{3.97\ V^2}{R}}$$

V : Km/h (mph)

R : m (ft) .

** main rail road Line , Secondary Line , yards : اعرف تعريف كل وحده والفرق بينهم

2 unbalanced elevation (Eu) , actual elevation (Ea)

$$\boxed{E_u = E_b - E_a}$$

يعطى بالسؤال

Ex : rail road with R = 450 ft , V = 20 mph , and Ea = 2 in

find Eu ?

Sol : $E_b = \frac{3.97 * (20)^2}{450} = \boxed{3.53\ in}$

$E_u = E_b - E_a = 3.53 - 2 = \boxed{1.53\ in}$

Length of Spiral :

- minimum Length "mm" (AREMA)* :

** metric :

$$L_{(m)} = 0.01216\, E_{u(mm)}\, V_{(kph)} \quad \text{or} \quad L_{(m)} = 0.744\, E_{a(mm)}$$

⇒ take the larger between them as min. length.

** in feet : نفس القوانين حوله

$$L_{(ft)} = 1.63\, E_{u(in)}\, V_{(mph)} \quad \text{or} \quad L_{(ft)} = 62\, E_{a(in)}$$ ⇐ خذ الاكبر

- For economic "excessive length costly" or obstruction make it impossible : في حال ذكرت في السؤال ⇐ بنضيف قانون اللي فوق :

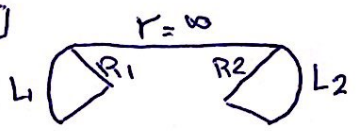
$$L_{s\,min(ft)} = 1.22\, E_{u(in)}\, V_{(mph)} \quad , \quad L_{s\,min(m)} = 0.0091\, E_{u(mm)}\, V_{(kph)}$$

** Reverse curve : min 100' or 3 sec of running time between curves (take larger). سؤال سنوات (٢ علامة).

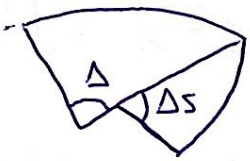
Horizontal Curves : انواعه

1. Centeral Circular Curve
2. Transition curve (Coposite and wholly transitional)
3. reverse curve
4. broken - back curve.
5. Two - center curve (compound)

4



5



Ex(1) : Determine the equilibrum elevation for a rail road curve with a radius of 600 m given a design speed of 80 kph , G = 1511 mm ?

Sol :

$$E_b = \frac{GV^2}{gR} = \frac{1511\,mm * \left(80 * \frac{1000}{3600}\right)^2_{(m^2/s^2)}}{9.81_{(m/s^2)} * 600m} = \boxed{126.93\ mm}$$

$$\boxed{E_b = \frac{11.9\,V^2}{R}}$$ * او مباشره على قانون

Ex(2) : Determine E_b in inches, for a $1^\circ 45'$ rail road curve given a design speed of 60 mph . G = 59.5 (standard) ?

غير معطى انت بدك تحفظها

Sol :

according to chord definition :

$$\sin\left(\tfrac{1}{2}D\right) = \frac{50}{R} \Rightarrow R = \sin\left(\frac{1^\circ 45'}{2}\right)^{-1} * 50 = \boxed{3274.1}\ ft$$

$$E_b = \frac{3.97\,V^2}{R} = \frac{3.97\,(60)^2}{3274.1} = \boxed{4.365\ in}$$

Ex(3) : it is a policy of a rail road to use a 150(mm) max. elevation (Ea) of the outer rail given a 100 kph max. train speed and curve radius of 550 m .

Determine the superelevation that should be used and the min. length of spiral ?

Sol :

$$E_b = \frac{11.9\,V^2}{R} = \frac{11.9(100)^2}{550} = \boxed{216.4\ mm}$$

$$L_{s\,min} = 0.744\,E_a = 0.744\,(150) = \boxed{111.6\ m}$$

$$L_{s\,min} = 0.01216\,E_u\,V = 0.01216\,(216.4 - 150) * 100 = \boxed{80.256\ m}$$

E_u

$\Rightarrow$ use $\boxed{L_{s\,min} = 111.6}$ since it larger

Vertical Alignment :

- profile : min. grade for railway ≥ 0.3
  max. grade for mainline = 1%
  max. grade for mountaineous = 2.5%
  max of LRT = (4 − 6)%
  Short section = 10%

min. Length :

$$A = G_2\,\% - G_1\,\% \begin{cases} + \text{ Sag} \\ - \text{ Crest} \end{cases}$$

$G \begin{cases} / \ \boxed{+} \\ \backslash \ \boxed{-} \end{cases}$

[*] PI at distance $x = L/2$ from BVC.

- old formula :

$$\boxed{L = A/R}$$

A : algebraic difference of grade (ft. per 100-ft sta.)
R : rate of change per 100-ft stationg (grade بال)

[*] يستخدم عندما لا يكون هناك سرعة .

- new formula :

$$\boxed{L = \frac{2.15\,V^2 A}{a}}$$

V : train speed (mph)
a : vertical acc. in ft/s^2 $\begin{cases} 0.1 \text{ for freight} \\ 0.6 \text{ for passenger train} \end{cases}$

** مهم جداً قراءة الشرح والحفظ بالسلايدات + حل امثلة على القوانين

[*] Critical issues with Vertical Curves.

حفظ

Transite rate :

$$F = F_b + KN$$

F = fare to be paid.
F_b : base fare.
K : inrement in price per zone.
N : no. of zones crossed.

Service frequency :

$$f = n/N$$

f : frequ. required (busses/hr)
n : demand for service (passenger/hr)
N : maximum no. of passenger per bus

Head way :

$$h = t_{da} + t_{db}$$

** Dwell time :

$t_{da} = aA + C$ (for alighting only) التنزيل
$t_{db} = bB + C$ (for boarding only) التحميل

** اقرأ القوانين من السلايدات و افهم كل قانون ورمز وإلى ماذا يشير .

Service capacity :

$$C_t = C_a + Z C_b \qquad R_c = 60\, C_t / h$$

تحويل وحدات

C_t : total vehicle capacity
C_a : Vechicle seating capacity
C_b : ultimate vehicle standing capacity
Z : allowable fraction of ultimate vehicle standing capacity.
R_c : max. rout capacity in passenger per hr
h : minimum head way in minutes

** يقال ان سؤال السنوات على هذا الموضوع يأتي بـ V اسطر وعلامه واحده .

Parking inventory :

- Parking supply (Vehs) :

$$P = \left(\frac{\Sigma n \; N T}{D}\right) * F$$

- افهم القانون والرموز وماذا تعني
وحل المثال اسفل القانون بالسلايدات
عن فهم واقرأ الملاحظات .

Average parking Duration :

$$D = \frac{\Sigma_x (N_x * X * I)}{N_T}$$

D : average parking duration , h/Veh
N_x : no. of vehicle parked for X intervals
X : no. of intervals parked
I : Length of the observation interval, h
N_T : total number of parked vehicles observed

<u>Ex</u> : see Table 12.8 : 12.7 تم عمل الجدول عن طريق جمع القيم من جدول
ومن خلال ما يحتويه من قيم نستطيع ايجاد D .

Turnover rate :

$$TR = \frac{N_T}{P_S * T_S}$$

TR : parking turnover rate , veh/stall/h
N_T : total no. of parked vehicles observed
P_S : total no. of legal parking stalls
T_S : durations of the study period, h

The Wind Rose :

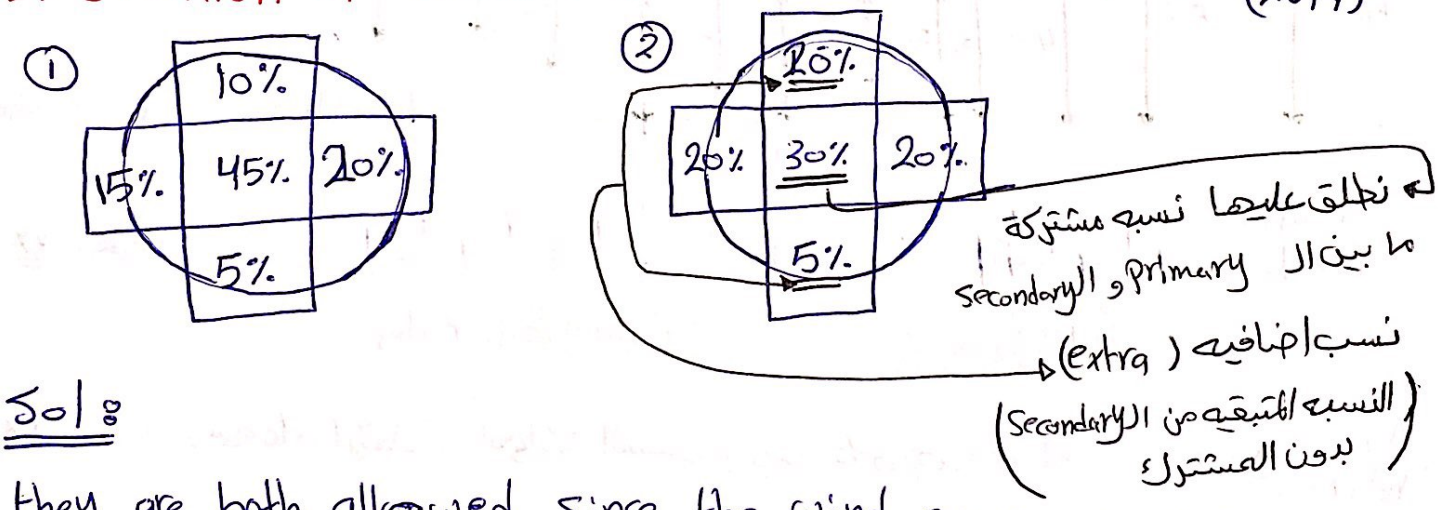
- سؤال ستوات فصلي بـ (٤-٥) علامات.

● فكرة السؤال :- الـ wind rose بتحتوي على Percentage of time (نسبة الوقت من السنة) للـ wind speed خلال السنة، باتجاهات معينة تكون على اطراف الدائرة allowed

وبالنسبة لمعايير بناء مدرج المطار (runway) يجب ان يكون باتجاه بحيث يشمل 95% من اوقات السنة (النسب الموجودة بالـ wind rose)

فاذا لم يشمل هذه النسبة، نقوم بوضعه بحيث يشمل اكبر نسبة ممكنة ونطلق عليه اسم (primary) ونقوم بانشاء مدرج ثاني نطلق عليه (secondary) باتجاه بحيث يشمل نسب اضافية توصلنا للـ 95% ويتم فتحه خلال اوقات معينة من السنة.

Ex: which of the wind roses are allowed? explain (فصل اول 2017)



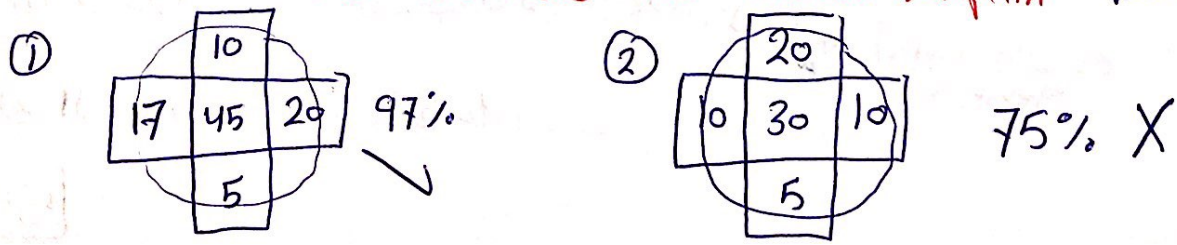
Sol:

they are both allowed since the wind coverge $\geq 95\%$

1. $10+15+45+20+5 = 95\%$ ✓
2. $20+20+20+30+5 = 95\%$ ✓

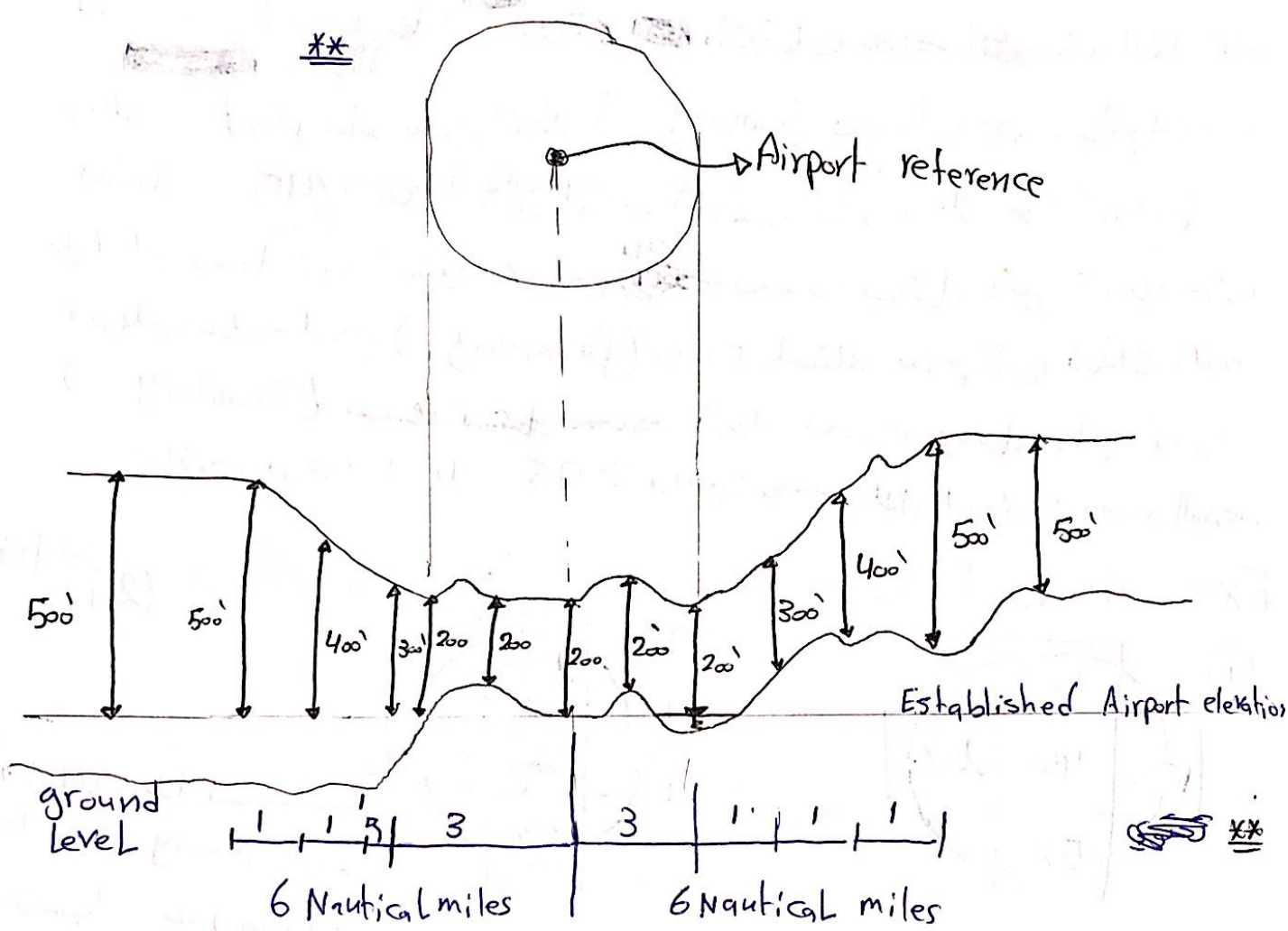
** ملاحظة اضافية ذكر انه في المدرج الاول نسبة اوقات الرياح بالـ primary اكبر لذلك سوف يفتح لوقت اطول.

Ex: which of the wind roses are allowed? explain (فصل ثاني 2017)



Objects Affecting Navigable Airspace :

* لحساب ارتفاع العوائق او المجسمات المسموح بها في المطار .



** تحتوي الرسمة على ارتفاعات العوائق المسموح بها على بعد 6 اميال بحرية من Airport reference .

** لاحظ خلال اول ٣ اميال بحرية مسموح بعائق 200' ارتفاعه ، بعدها كل 1 ميل يرتفع 100' ⟸ اقصى حد مسموح هو 500' مفهوم اكثر (سنوات) .

** سؤال السنوات : تحويل من ft ⟸ ميل ⟸ ميل بحري ثم حساب الارتفاع المسموح ومقارنته مع ارتفاع العائق .

مهم جداً اسأل الدكتورة :

1. مرجع الارتفاعات المسموحة هو الاعلى بين ground level و establish Airport elevation .

2. ال Tower يتم بناءه على ؟؟

سنوات

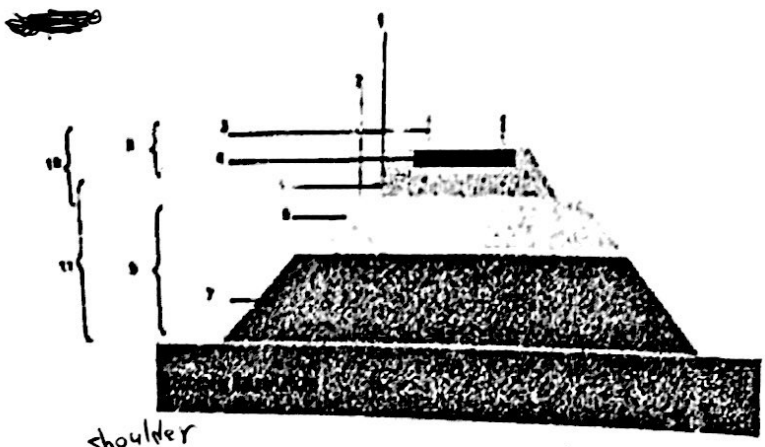
Dr. Randa OjabMujalli

1-4. What are the main differences in design between railroad and highway ? (1.5 points)

تأكد : ٤

1. Design Speed
2. Degree of curvature
3. superelevation

1-5. for the following cross section of a railroad, list the names of the layers designated by the numbers next to each: (5.5 points)



1: Ballast ;2: Cess (shoulder) ;3: rails ;4: sleeper ;5: Ballast sub ball ;6: Blanket 7: Subgrade
8: Track ;9: formation ;10: Permanent way ;11: Track foundation

1-6 What are the main functions for crossties in railroads? (2 points) [main function for Crossties in railroad]

1- spreading Loads to ballast
2- Providing Correct gage between rails
3- anchoring the track
4- making the needed adjustments to vertical Profile

Q1.6 : what are the advanges of Long rail? (2 point)

1- Less maintenance costs.
2- higher speeds are allowed.
3- Less damage.
4- Smother ride.

Q1.7 : what is the route capacity if mini buses maximum seats capacity is used as the total Vehicle capacity, Knowing that the minimum headway between successive ~~buses~~ Vehicles is equal to 10 min? (1 point)

Sol :

maximum sets capacity (C_a) = total vehicle capacity (C_t)
means that ~~B~~ Z equal zero

assume C_t (mini buses) = 24 seats

$$P_C = \frac{60 \times 24}{10} = \boxed{144 \text{ passengers/hr}}$$

Q1.8 : what are the types of bus berths? Draw a sketch to illustrate each? (4 point)

1- Linear berths | 2- saw tooth berths | 3- Angle Berth | 4- Drive through berth

الرسمات بالسلايدات

Q1-10: what is the maximum walking distance that 75% of parkers in Cites with Large population will be to walk from their parking space to their final destination? (1 point)

جملة حرفية بالسلايدات: Even in Cities of Large population (1-2 millions), 75% of drivers park within a 0.25 mile (400 m) of their final destination.

Question 2 (3 points):

A parking study has found that the average parking duration in the City is 35 min, and that the following spaces are available within the 14 hour study period (6:00 – 20:00). How many vehicles may be parked in the study area in one 14 hours, knowing that the total number of Legal parking stalls is 60?

number of spaces	Time available
100	6:00 – 20:00
150	12:00 – 20:00
200	6:00 – 12:00
300	8:00 – 18:00

Sol:

$$P = \left(\frac{\Sigma n \, N_T}{D}\right) * F$$

$$F = \frac{N_T}{P_s * T_s} = \frac{(100+150+200+300)}{60 * 14} = \boxed{0.893}$$

$$P = \frac{(100*14 + 150*8 + 200*6 + 300*10)}{35/60} * 0.893 = \boxed{104{,}10 \text{ Vehs}}$$

Dr. Randa Oqab Mizjalli

Question 3 (3 points):

runway

An airport is being planned to serve a city of 36000 people. The visual is to be 3600 ft long. Indicate whether or not the following objects will be considered obstruction to air navigation by the FFA. (HINT: 1 nautical mile = 6076 ft; 1 mile = 5280 ft):

- A 220 ft tower that is not in the landing approach, located 3.1 miles from the airport reference point. The ground elevation at the tower is 25 ft higher than the established airport elevation?

Question 4 (5 points):

The data given in the tables below, [illegible] wind rose [illegible] airport. What would be the best [illegible] for a [illegible] on these prevailing winds?

Table 1: The percentage of time [illegible] cross wind is than the maximum allowable is the in [illegible] direction.

Orientation of runway	% of coverage
90-270	90
0-180	80
30-210	88
160-340	91

Table 2: The percentage of overlap (المشترك) between the different orientations

Orientation	90-270	0-180	30-210	160-340
90-270	100%	100%	99%	98%
0-180	100%	100%	94%	100%
30-210	99%	94%	100%	95%
160-340	98%	100%	95%	100%

Sol :

** تأكد من حله

Q3 : (3 point)

Converst 3.1 mile to nautical mile

1 mile → 5280 ft
3.1 → X

⇒ $\boxed{X = 16368 \text{ ft}}$

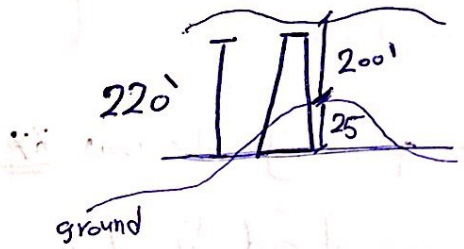
1 nautical mile → 6076 ft
X → 16368 ft

⇒ $\boxed{X = 2.694 \text{ nautical mile}}$

⇒ then the allowable elevation of obstruction = 200'

⇐ اسفل ال Tower معطى انه ال ground اعلى من ال establish elev. of Air port لذلك هي المرجع و حسب ال Tower اين منشأ.

(*) assume Tower on establish elev. ~~for~~ Airport



⇒ 220 - 25 = 195' < 200' ⇒ ok

* اما اذا كان غير مبني على establish elev. بكون not ok.

Q4 : (5 point) : The data given in the tables below, shows the result of establishing a wind rose for an airport, what would be the best orientation for a runway based on these prevailing winds?

Table 1 : the percentage of time the cross wind is than the maximum allowable in this direction.

Table 2 : The percentage of overlap (المشترك) between the different orientations.

Sol : نلاحظ من الجدول الاول بأن جميع المدرجات نسبه الرياح فيهم اقل من 95% لذلك نأخذ اعلى واحد ونعتبره (primary) و نحتاج لفتح مدرج اخر (secondary) حتى نكمل النسبه لـ 95% .

تأكد منها : ⇒ $\boxed{100\% - \text{المشترك} = \text{extra الاضافي}}$ ⇒

From Table ② we compute the extra

preentation	90-270	0-180	30-210	160-340
90-270	0	0	1%	2%
0-180	0	0	6%	0
30-210	1%	6%	0	5%
160-340	2%	0	5%	0

** نسبه الـ primary + الـ extra = الـ Total للمطار التي لازم تكون > 95%

ونلاحظ انه لا يوجد الا حل واحد :-

primary (160-340) = 91%

additional wind coverge (extra) between (160-340) & (30-210)

= 5%

so the secondary (30-210)

Total = 91% + 5% = $\boxed{96\% > 95\%}$

Question 1 (23 Points):

Answer the following questions:

1-1. What is the minimum and maximum grade used in the design of vertical alignment for main railroad lines? (1 point) max. = 1 % min. = 0.3 %

1-2. What are the forces that affect the movement of train when moving on a curve? (1.5 points)

1. weight
2. Resisting force excreted be the rail
3. Centrifugal force

1-3. Draw the following curves, and show the following on each: (7.5 points)

- The main points on the curves.
- The change of centrifugal force along the curves
- The change of radius along the curves

1. Composite curve

رسمات السلايدات موضح عليها
النقاط .

2. Wholly transitional curve

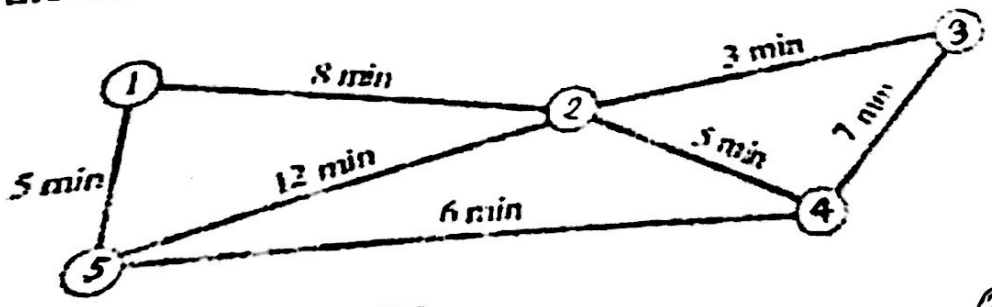
Question 4 (4 points):

The following table illustrates the number of observed vehicles arriving to a parking lot where their arrivals and departures are exponentially distributed. 5 entrances are available to vehicles at arrival and 5 exits at departure; determine the total time spent in the system and the probability of waiting in a queue?

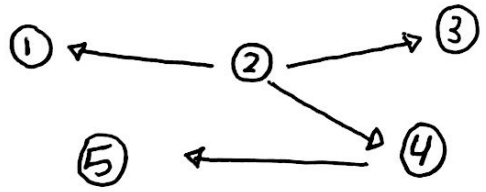
Time period	Observed no. of arrivals	Observed no. of departures
8:00-8:10	50	5
8:10-8:20	40	10
8:20-8:30	30	15

Question 5 (3 point(s):

- Determine the minimum path for nodes 2, 4 in Figure below.
- Sketch the final skim trees for nodes 2, 4.

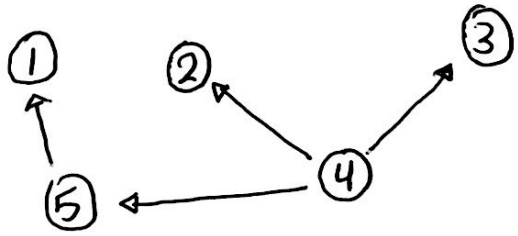


min. Path : $\boxed{2}$:



2 → 1
2 → 3
2 → 4
2 → 4, 4 → 5

$\boxed{4}$:



4 → 2
4 → 3
4 → 5
4 → 5, 4 → 1

Question 5 (2 points):

Given an intersection angle Δ= 23°00'00" and a degree of curve= 1°45'00", compute the tangent distance, curve length, and the station of point of tangency (PT) of a circular horizontal curve for a railway track. The station of the point of intersection (PI) is 27+85.50? (use metric units)

$$R = \frac{50'}{\sin\left(\frac{1°45'}{2}\right)} = 3274.17' \times 0.3048 = \boxed{997.97\ m}$$

Dr. Ramla OqabMujalli

1-7. What is the route capacity if the vehicle seating capacity is 70 passengers, and ultimate vehicle standees capacity is 20. for safety the system operator does not allow to have more than 40% the ultimate capacity of standees available on board any vehicle, knowing that the minimum headway between successive vehicles is equal to 10 minutes? (1 point)

1-8. What are the types of mass transit system classification? Draw a sketch to illustrate each? (5 points)

Q5 : $\Delta = 23^\circ 00' 00''$ $D = 1^\circ 45' 00'$

$$R = \frac{15}{\sin\left(\frac{1^\circ 45'}{2}\right)} = \boxed{982.25 \text{ m}}$$

$$L = \frac{R \Delta \pi}{180} = \frac{982.25 * 23^\circ 00' 00'' * \pi}{180} = \boxed{394.3 \text{ m}}$$

$$T = R \tan\left(\frac{\Delta}{2}\right) = \boxed{199.84 \text{ m}}$$

$$PC = PI - T = 2785.5 - 199.84 = \boxed{2585.66 \text{ m}}$$

$$PT = PC + L = \boxed{2979.96 \text{ m}}$$

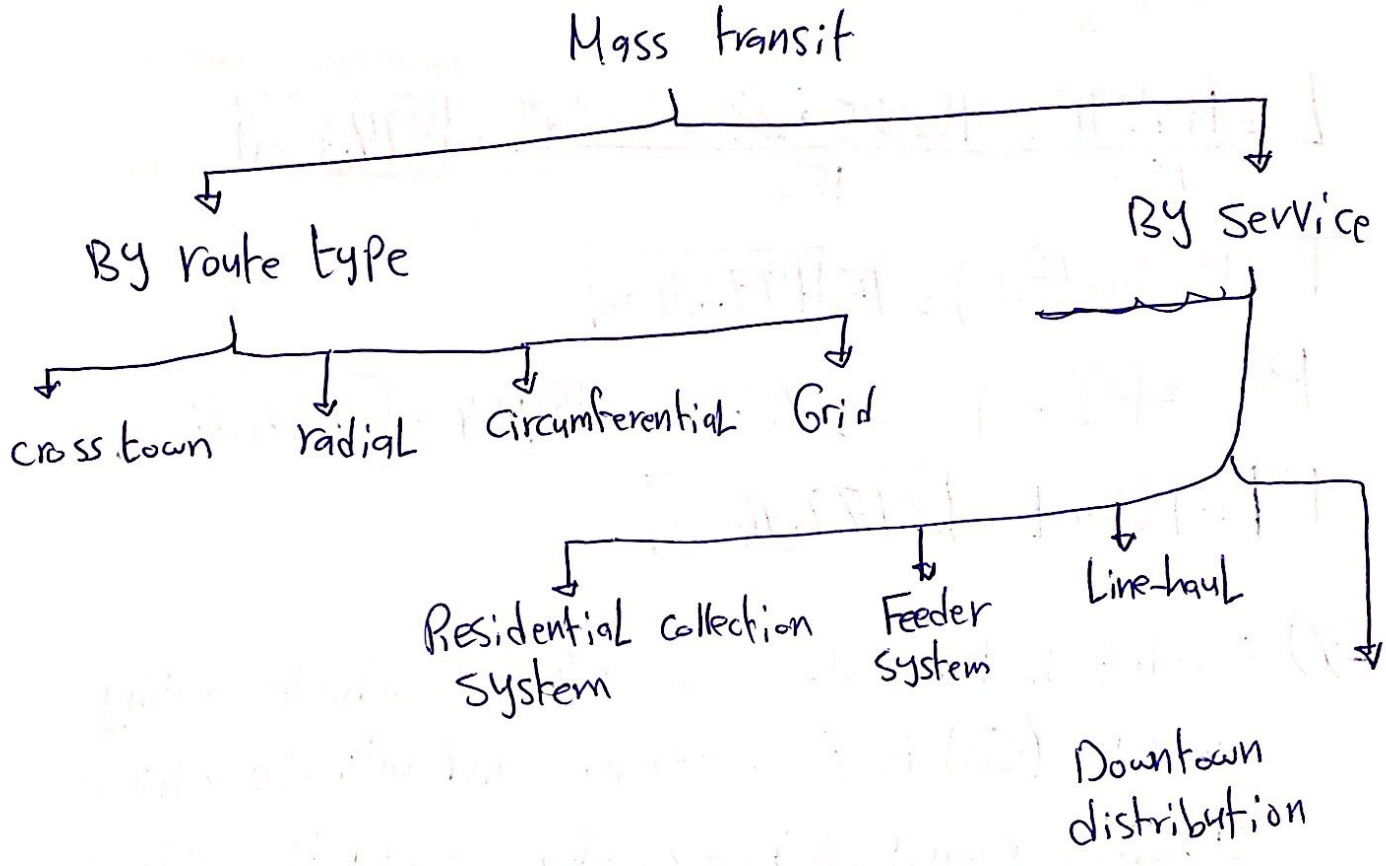
(1-7) : what is the route capacity (Rc) if vehicle seating capacity (Ca) is 70 passenger, and ultimate vehicle standees capacity (Cb) = 20, for safety the system operator does not allow to have more than (Z) 40% the ultimate capacity of standees on board any vehicle, knowing that the minimum headway between successive vehicles is 10 mint ? (1 point) !!! omg

Sol :

$$C_t = C_a + Z C_b = 70 + 0.4(20) = \boxed{78}$$

$$R_c = 60 * C_t / h = \frac{60 * 78}{10} = \boxed{468 \text{ passenger per hr}}$$

(1-8) : What are the types of mass transit system classification ?



Dr. Randa OqabMujalli

1-9. **What are the sources that can be used to finance mass transit? (2 points)**

1. General taxes (property)
2. Auto disincentive taxes (gasoline)
3. Direct benefit financing (Local goverment)
4. non-transit related taxes (cigarette taxes)

1-10. **what is the median walking distance that a parker will be willing to walk to her/his parking space in a CBD? (1 point).**

500 ft → 0.1 Miles → 160 m

Question 2 (6 points):

A parking lot has a single entrance. The time between cars arrivals at the entrance is exponentially distributed with a mean arrival rate of 1.5 veh/min. The time it takes the cars to get into the parking lot is exponentially distributed with a mean rate of 2 veh/min. when more than 5 cars are in the system, the queue backs up (يعود للخلف) onto the road and effect the traffic movement. What is the probability that the number of cars in the system will exceed 5?

Dr. Randa Ogaf Ibrahim

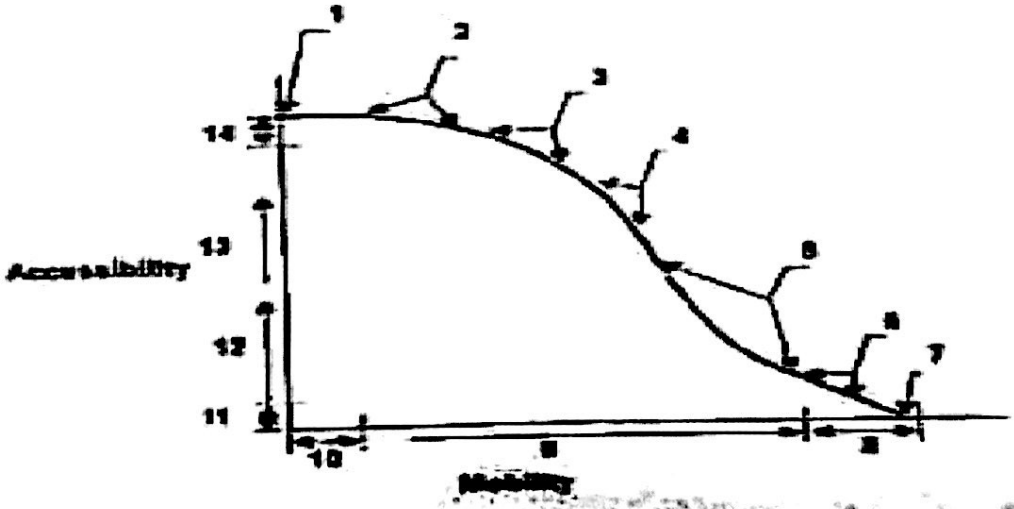
1-4. You have the following three alternatives which were ranked according to the listed MOE's, determine which of them should be selected if they are all mutual exclusive alternatives knowing that 1 is the highest and 5 is the lowest (Justify your answer) (2 Points)

MOE	Alternatives			
	DN	1	2	3
Travel Time	1	2	5	5
Accidents	1	3	5	4
Noise	1	4	3	4
Tax loss	5	2	1	3
Cost	5	3	1	2

Alternative selected.

Justification:

1-5. On the following curve that represent the relationship between accessibility and mobility, what does each of (1-14) represent on the curve. (1-7 represent classes of roads) (7 points)



1: 2: 3:
8 9: 10:

(1-4) : You have the following three alternatives which were ranked according to the Listed MOE's, determine which of them should be selected if they are all mutual exclusive alternative, Knowing than 1 is the highest and 5 is the Lowest :

Sol : Σ Ranked for alternative :

DN → 1+1+1+5+5 = 13

1 → 2+3+4+2+3 = 14

2 → 5+5+3+1+1 = 15

3 → 5+4+4+3+2 = 18

⇒ Select alternative DN since Σranked = 13 and we know that 1 is highest .

highest ذ اقل اشي هو ال

(1-5) :

الوسطة حرفيه بالكتاب + جميع الرموز عليها

(7 Point) ⟹ !!!

Dr. Hamdi Ogdah Agail

Question 3 (5.5 point(s))

The data given in the tables below, shows the results of establishing a wind rose for an airport. What would be the best orientation for a runway based on these prevailing winds, if the maximum allowable crosswind speed is 15 km/hr, and the proposed runway length is 3200 feet?

Table 1: The percentage of time the crosswind is less than the maximum allowable

Orientation of runway	% of coverage/speed range		
	0-5 km/hr	5-10 km/hr	10-15 km/hr
N-S	40	30	20
E-W	35	25	20
NE-SW	40	30	18
SE-NW	40	30	21

Table 2: The percentage of extra coverage for runways between the different orientations

Orientation	N-S	E-W	NE-SW	SE-NW
N-S	0	4	5	6
E-W	4	0	7	0
NE-SW	5	7	0	2
SE-NW	6	0	2	0

Q3: (5.5 point):

The data given in the Table below, shows the result of establishing a wind rose for an airport. what would be the best orientation for a runway based on the prevailing winds. if the maxi allowalde crosswind speed is 15 Km/hr and the proposed runway Length is 3200 feet?

Table 1: The percentage of time the crosswind is Less than the max. allowable.

orientation of runway	% of Coverge speed range		
	0-5 km/hr	5-10 km/hr	10-15 km/hr
N-S	40	30	20
E-W	35	25	20
NE-SW	40	30	18
SE-NW	40	30	21

Table 2: The percentage of extra coverage for runways between the different orientation.

orientation	N-S	E-W	NE-SW	SE-NW
N-S	0	4	5	6
E-W	4	0	7	0
NE-SW	5	7	0	2
SE-NW	6	0	2	0

الحل: ⟹

Sol :

orientation of runway	Σ %
N-S	40+30+20 = 90 %
E-W	35+25+20 = 80 %
NE-SW	40+30+18 = 88 %
SE-NW	40+30+21 = 91 %

بما انه كلهم اقل من 95 %

بعتبرهم (Primary runway) وبحتاج

لافتح (Secondary runway) عشان اكمل

النسبه لـ 95 %.

orientation	N-S	E-W	NE-SW	SE-NW
N-S (90%)	90+0 = 90	90+4 = 94	90+5 = 95	90+6 = 96
E-W (80%)	80+4 = 84	80+0 = 80	80+7 = 87	80+0 = 80
NE-SW (88%)	88+5 = 93	88+7 = 95	88+0 = 88	88+2 = 90
SE-NW (91%)	91+6 = 97	91+0 = 91	91+2 = 93	91+0 = 91

اذكر لها انه اي نسبه > 95 % يمكن استخدامها ولكن افضل

نسبه هي اكبر اشي فيهم

we will use orientation SE-NW (primary) and N-S (secondary) as the best one since it 97 % > 95 %