CE353 PRINCIPLES OF TRANSPORTATION AND TRAFFIC ENGINEERING
PROBLEM SET 2

1. An upgradient of 2.5% meets a downgradient of 2% at station kilometer 10+834.26 and at elevation of 64.46 m. The length of vertical curve is 140 m. Calculate ;

a) Elevations on the curve at even 25 m. St. Km.s
b) Elevations on the curve using 25 m. from PVC and PVT
c) St. Km. and elevation of the the highest point on the curve.

2. A sag type parabolic vertical curve was designed according to rider's comfort criteria ; using the following formula to calculate the length of the vertical curve:

$$L = A.V^2 / 395 \quad (\text{in meters})$$

If the mid-curve offset distance for this curve is 1.26 m , find:

a) design speed of the highway if $G_1 = -2.4\ \%$ and $G_2 = 4.8\ \%$
b) the offset distances for every 20m starting from PC .

3. Calculate at every 20 meters , station km.'s , offsets, and curve elevations of a sag type vertical curve if the following data is given:

L=160m
Elev. PI = 422.18 m
St. Km. PI = 4+246.18
$G_1 = -3\ \%$
$G_2 = 2\ \%$

4. What should be the length of crest type vertical curve , if passing is not allowed ? (Consider upper limits for sight distances)

$G_1 = -4\ \%$
$G_2 = -7\ \%$
$V_{design} = 80$ km/hr

5. Consider a parabolic curve on a 2-lane highway.

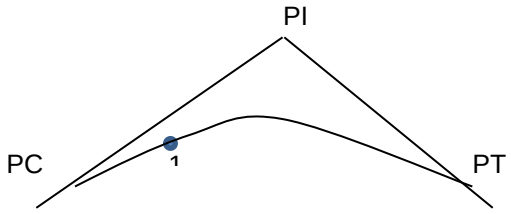
L= 180m
$G_1 = 2\ \%$
$G_2 = -3\ \%$
St. Km. PI = 3+700
Elev. PI = 45.6 m

Find the station kilometer and the elevation of the point on the curve which has -2 % grade.

6. On a vertical curve , elevations of PC , PI and PT are given as 285 m, 280.5 m and 288 m respectively. Taking the length of that curve as 300 m and St. Km. of PC as 3+500.00 ,

a) Find the algebraic summation of grades (A) and draw the vertical curve
b) Compute tangent line and curve elevations , offset distances, and St. Km.'s at every 60 m. starting from both ends (i.e. from PC and PT)
c) Find the sight distance for the given conditions.

7.



St.Km. PI= 3+200.00

Elev. PI= 348 m , L=400 m

In a parabolic type of a crest vertical curve as shown above, the curve elevation at St.Km. 3+050 (point 1) is given as 343.28 m. If the mid-curve offset (Ym) is 3.5m., find;

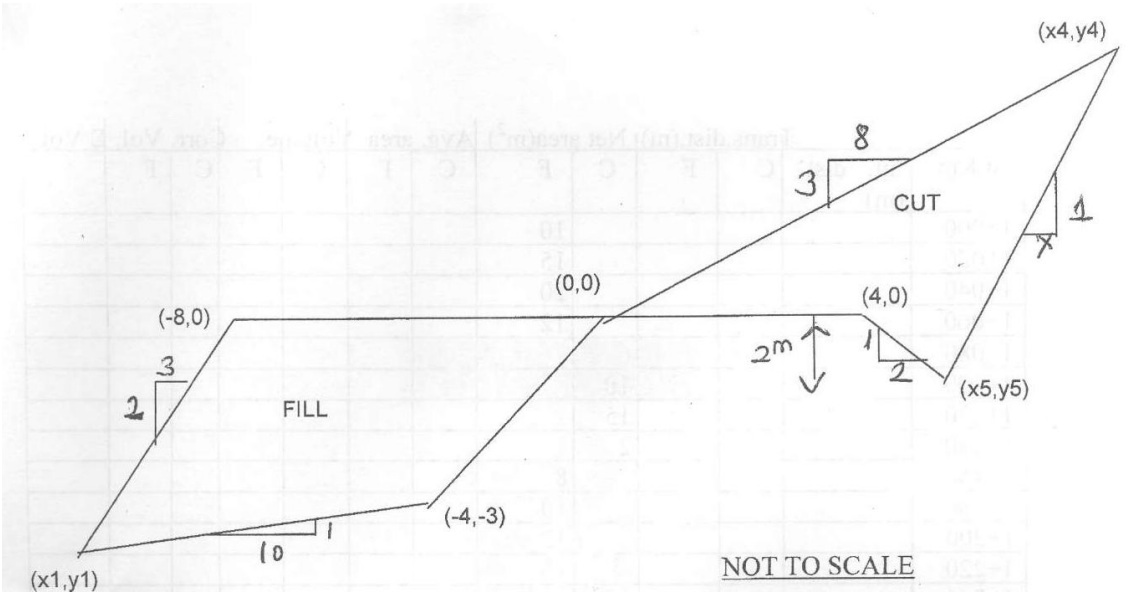
a. the slopes G_1 and G_2,
b. the St.Km. and elevation of highest point on the curve.
c. the St.Km. of a second point on the curve having the same elevation with point 1 ,i.e, 343.28m.
d. Assuming the design speed as 80 km/hr and the corresponding sight distances as:

Stopping sight distance (SSD)=110m
Passing sight distance (PSD) =550m

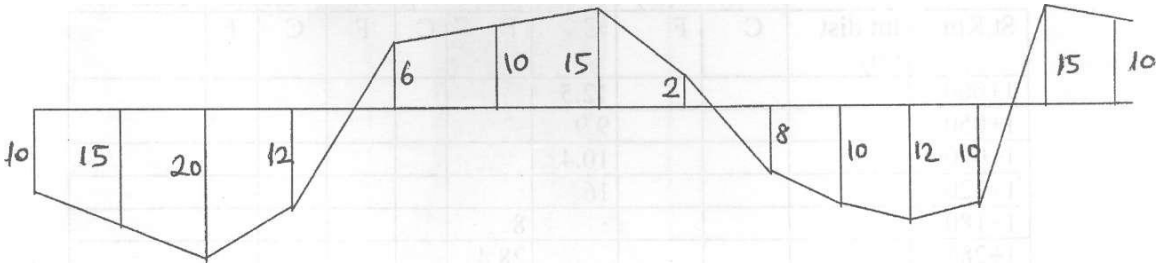
Investigate whether one of these sight distances are provided or not with the existing curve elements.

8. Find the value of cut slope (x) for the cross-section given below such that the resulting net area shall be 7 m^2 cut , i.e.

$$\text{Net Area} = A_{cut} - A_{fill} = 7\ m^2$$



9. Net area diagram of a roadway section is given below. Fill in the volume sheet considering 10 % swelling.



St.Km	Int.dist (m)	Trans.dist(m)		Net area(m^2)		Average Area		Volume		Corrected Volume		Cumulative Volume
		C	F	C	F	C	F	C	F	C	F	
1+000					10							
1+020					15							
1+040					20							
1+060					12							
1+080				6								
1+100				10								
1+120				15								
1+140				2								
1+160					8							
1+180					10							
1+200					12							
1+220					10							
1+240				15								
1+260				10								

10. a) Fill in the volume sheet given below considering no swell or shrinkage

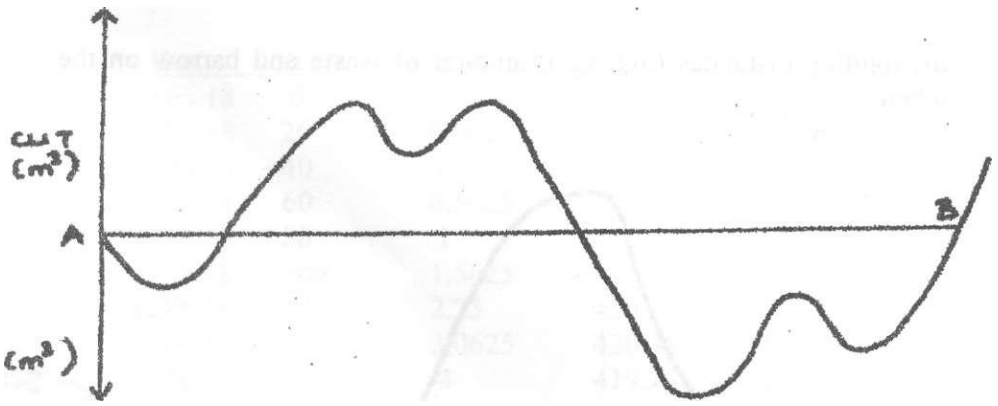
b) What should be the percentage of swell so that last point of the mass diagram is on the base line.

St.Km	Int.dist (m)	Trans.dist(m)		Net area(m^2)		Average Area		Volume		Cumulative Volume
		C	F	C	F	C	F	C	F	
1+000				12.5						
1+050				9.9						
1+070				10.4						
1+120				16						
1+180					8					
1+280					28.4					

11. Fill in the volume sheet given below using 10 % swelling. Assume all sections as complete cut or complete fill.

		Trans dist(m)		Net area(m^2)		Avg area		Volume		Corr. vol.		Cum vol
St.Km.	Int dist (m)	C	F	C	F	C	F	C	F	C	F	
1+000												0
1+050												550
1+070												825
1+120				15								1485
1+180					10						120	1662
1+280												-230

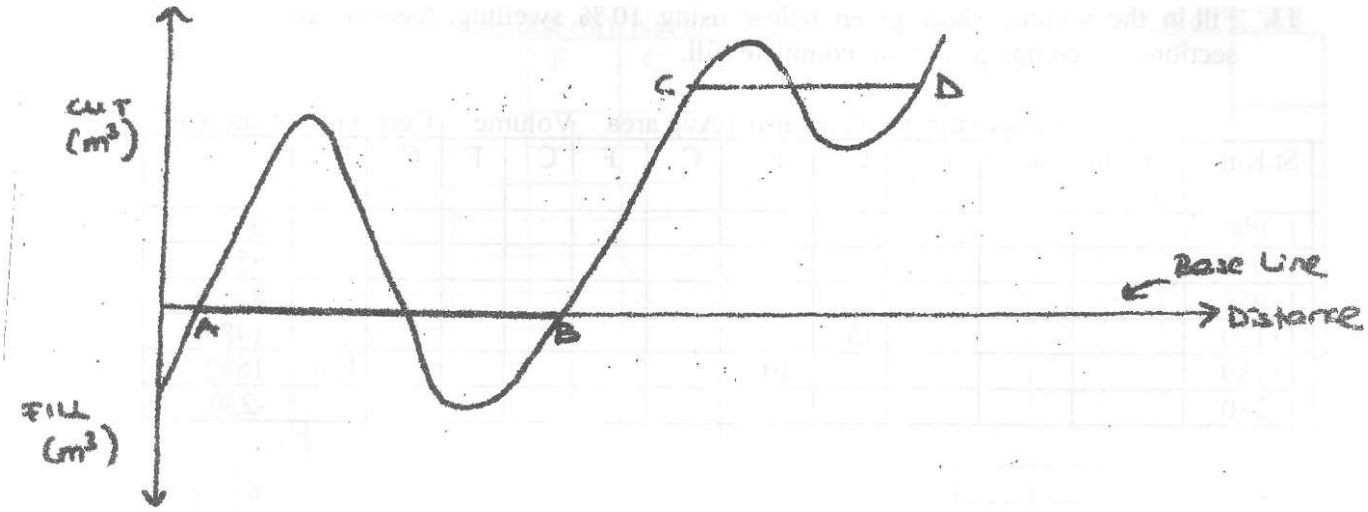
12. Draw the probable profile of the given mass diagram.



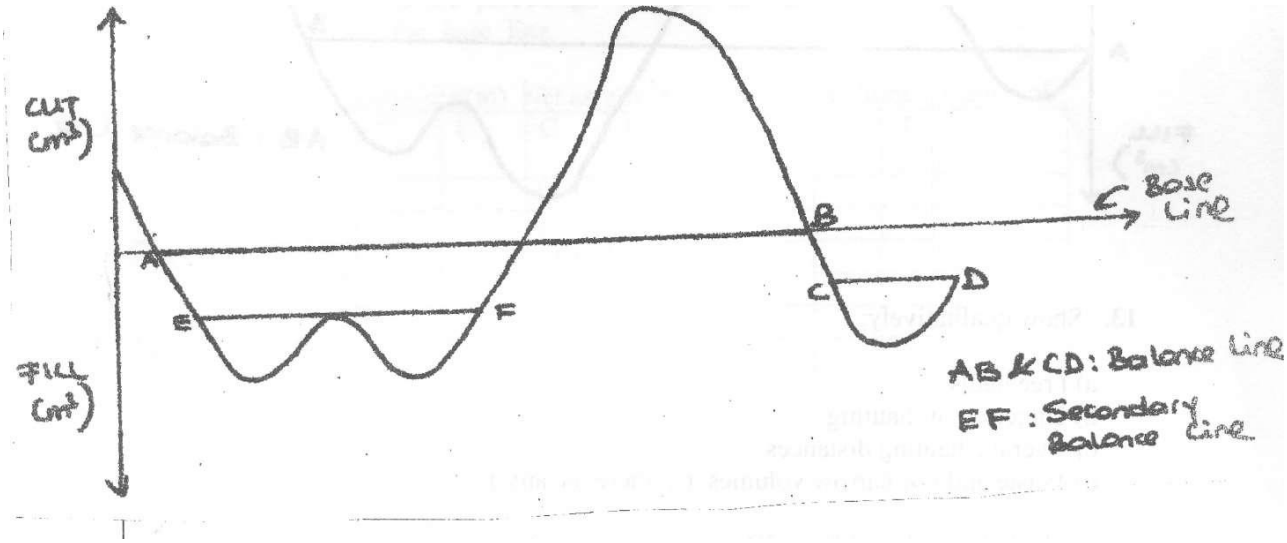
13. Show qualitatively;

a) Free hauls
b) Direction of hauling
c) Average hauling distances
d) Waste and / or barrow volumes (if there is any)

for the balance line AB - CD of given mass diagram.



14. Show free hauls, hauling distances (average), amount of waste and barrow on the mass diagram given below.



ANSWERS TO SELECTED PROBLEMS

1. c) St. Km. of highest point = 10 + 842.04 and its elevation is = 63.68 m

2. a) V= 87.63 km/hr , can be taken as 80 km/hr

b)

X (m)	Offset dist. (m)
0	0
20	0.1029
40	0.4114
60	0.9257
80	1.6457
100	2.5714
120	3.7029
140	5.0399

3.

St. Km.	X(m)	Offset (m)	bX+c	Curve elev.(m)	
4+166.18	0	0	424.58	424.58	
+186.18	20	0.0625	423.98	424.04	
+206.18	40	0.25	423.38	423.63	
+226.18	60	0.5625	422.78	423.34	
+246.18	80	1	422.18	423.18	
+266.18	100	1.5625	421.58	423.14	
+286.18	120	2.25	420.98	423.23	
+306.18	140	3.0625	420.38	423.44	
+326.18	160	4	419.78	423.78	OK✓

4. L= 48 m

5. St. Km.= 3+754
Elevation = 43.8 m

6. a) A= 8%

b)

St. Km.	X(m)	Tangent elev(m)	$d=aX^2$	Curve elev.(m)
3+500	0	285	0	285
+560	60	283.2	0.48	283.68
+620	120	281.4	1.92	283.32
+650	150	280.5	3	283.5
+680	120	282	1.92	283.92
+740	60	285	0.48	285.48
+800	0	288	0	288

c) S_s = 159.46 m

7. a) G_1=3% G_2=-4%
b) St. Km. = 3+171.43 Elev.= 344.57m
c) 3+293.00
d) For L=400m ⇒SSD=193.91m>110m and PSD=222m <550m. Therefore, SSD is satisfied, but PSD is not.

8. X=1

9.

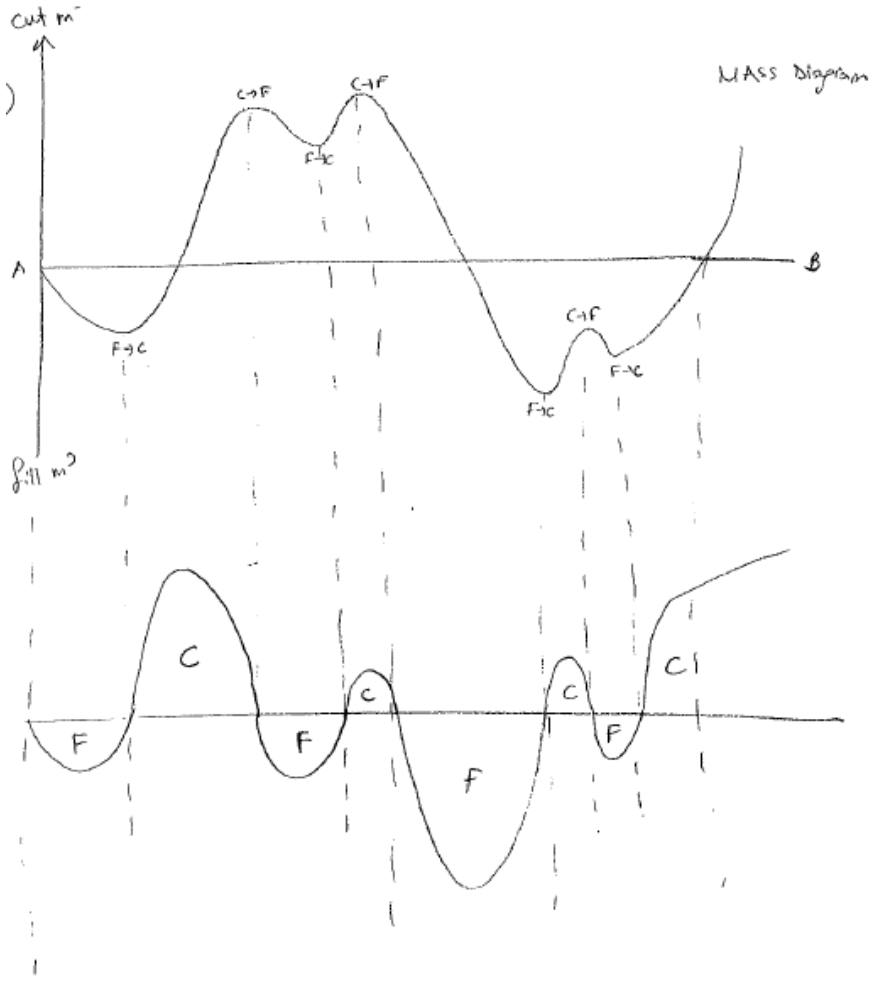
St.Km	Cum. Vol. (m^3)
1+000	
+020	-250
+040	-600
+060	-920
+080	-978
+100	-802
+120	-527
+140	-340
+160	-399.6
+180	-579.6
+200	-799.6
+220	-1019.6
+240	-960.6
+260	-685.6

10. a)

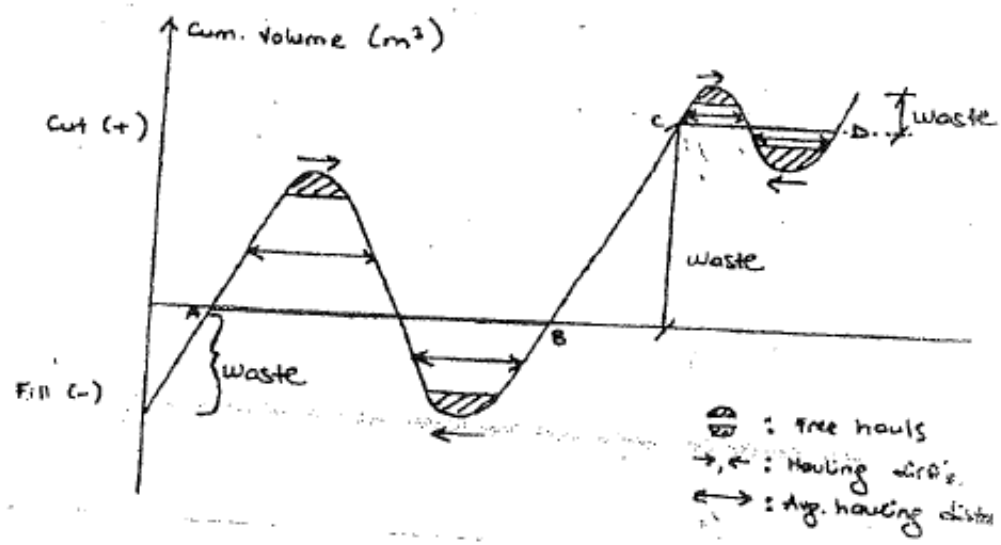
St. Km.	Cum. Vol.
1+000	
+050	560
+070	763
+120	1423
+180	1663
+280	-157

b) 9 % swell

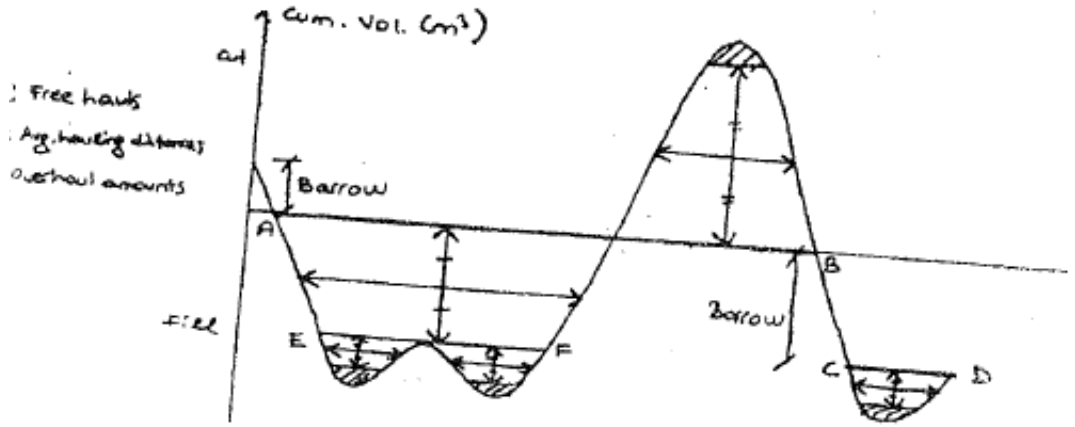
12.



13.


Cum. Volume (m³)
Cut (+)
Fill (-)
waste
waste
waste
A
B
C
D
: free hauls
→,← : Hauling dist's.
↔ : Avg. hauling dist.

14.


Cum. Vol. (m³)
Cut
Fill
: Free hauls
Avg. hauling distance
Overhaul amounts
Borrow
Borrow
A
B
C
D
E
F