Menoufia University
Faculty of Engineering
Civil Engineering Dept.
Final Examination, June 2014

Highway Geometric Design
M. Sc.
Time Allowed: 3 Hours
Date: 12 /6/2014

ANSWER ALL QUESTIONS

QUESTION 1 (35 MARKS):

a) Discus the differences in function associated with each of different road types (Arterials, Collectors, and Locals) - Use sketches to assist your answer.

b) What are the functions of the climbing lane and emergency escape ramp? When a climbing lane is justified on a two-lane road? Also, explain the factors influencing the longitudinal grades of a road.

c) List the main cross-sectional elements of the roadway and describe the functions of shoulders, medians and curbs.

d) Draw the highway cross section, showing all elements, in the following cases:

- Rural two-lane, two-way
- Urban multilane divided highway

e) Derive the Superelevation formula, ($R = \frac{V^2}{127(e + fs)}$).

f) Show with illustrations the method of attaining the superelevation by rotation around median edges.

g) Differentiate between Superelevation runoff on curves with spirals and curves without spirals (use skectshes).

h) Explain the factors that should be considered in the design of vertical curves?

i) Describe the factors that must be taken into account in the design of parking facilities?

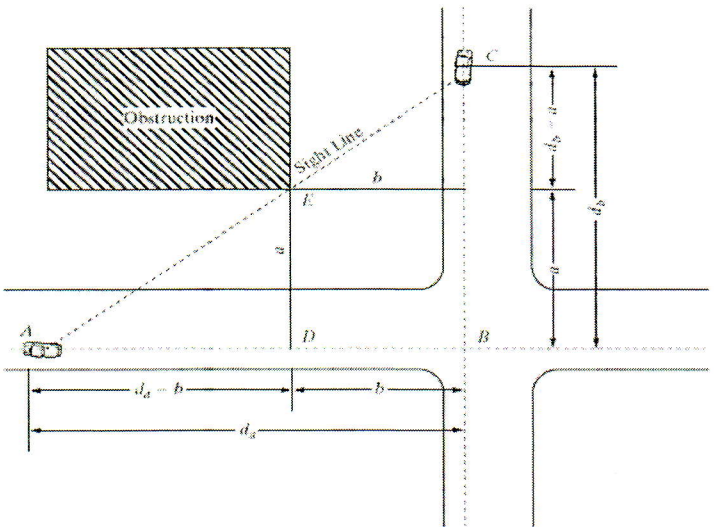
j) Briefly describe the different principles involved in the design of at-grade intersections.

k) What are the main functions of channelization at an at-grade intersection?

l) For Intersection sight distance, differentiate between approach and departure sight triangles?

QUESTION 2 (15 MARKS):

a) At an Intersection with no traffic control, an obstruction is located 13.50 m from the centerline of the right lane of a local road (b in the figure) and 19.5 m from the centerline of the right lane of an intersecting major road (a in Figure 2). If the speed limit on the major road is 55 Km/h, what should the speed limit on the local road be such that the minimum sight distance is provided to allow the drivers of approaching vehicles to avoid possible accident by adjusting their speeds? Approach grades are 2%.



b) A minor road intersects a major four-lane divided road with a design speed of 70 mi/h and a median width of 6 ft. The intersection is controlled with a stop sign on the minor road. If the

design vehicle is a passenger car, determine the minimum sight distance required on the major road for the stopped vehicle to turn left onto the major road if the approach grade on the minor road is 4%.

QUESTION 3 (25 MARKS):

a) A 490 m long sag vertical curve has a PVC at station 37+00 and elevation 460m. The initial grade is 3.5% and the final grade is +6.5%. Determine the elevation and stationing of low point, PVI, and PVT.

b) A highway reconstruction project is being undertaken to reduce accident rates. The reconstruction involves a major realignment such that a 100 km/h design speed is attained. At one section on the highway, a crest vertical curve with 245 m length is existed. Measurements show that at distance (x) 108 m from the PVC, the vertical curve offset (y) is 1 m. Assess the adequacy of the existing curve in the light of reconstruction design speed of 100 km/h and, if the existing curve is inadequate, compute a satisfactory curve length.

N.B. ($L = \frac{AS^2}{658}$ S≤L, $L = 2S - \frac{658}{A}$ S>L)

c) An equal tangent sag vertical curve is designed with the PVC at station 33+20 and elevation 290 m, the PVI at station 33+75 and elevation 288.74 m, and the lowest point at station 33+65. Determine the design speed of the curve; use the below table to assist with your answer.

Design Speed (km/h)	20	30	40	50	60	70	80	90	100	110	120	130
K for Headlight control (m)	3	6	9	13	18	23	30	38	45	55	63	73

Question 4(25 marks)

a) Find the minimum distance between the edge of an existing building, located in the side of a horizontal curve, and centerline of a 4-lane divided highway. Design speed is 100km/h, lane width is 3.5m, sidewalk width is 2m, and median width is 3m. The degree of curve is 5°.

d) For a horizontal alignment of a two-lane highway, a left turn curved reach with 415 m radius and a transitional parameter (A) of 240 m was needed. If the road has a 1.5% crown slope, 7.5 m road width, design speed of 100 km/h, and elevation of centerline is (85.00) m. Superelevation will be achieved by rotation around centerline. Draw the progress of pavement edges and find the elevations of inside and outside edges at 1/2 of the spiral length then draw the cross section. (Assume f_s =0.14).

Metric	
Design speed (km/h)	Length of leg (m)
20	20
30	25
40	35
50	45
60	55
70	65
80	75
90	90
100	105
110	120
120	135
130	150

Length of sight triangle leg- Case A- No traffic control

Design vehicle	Time gap (t_g) (seconds) at design speed of major road
Passenger car	7.5
Single-unit truck	9.5
Combination truck	11.5

Time Gap for Case B1—Left Turn from Stop