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

Highway Engineering
4th Year
Time Allowed: 3 Hours
Date: 31/5/201

Answer all questions and assume any missing data.
Use sketches to describe your answers where appropriate.

PART I (Geometric Design)

Question (1) (16 marks)

a) Explain briefly the design process of a proposed highway? Indicate some of the criteria used for evaluating alternative routes to select the best route.

b) List the main cross section elements and discuss the functions of shoulders.

c) When and why widening be introduced in horizontal curves? Discuss the factors affecting such widening.

d) Describe the functions and configurations of emergency escape ramps?

e) Compare between the length of vertical curve needed to satisfy comfort factor and that needed to satisfy headlight sight distance criterion? What is the appropriate length for improved appearance of sag vertical curves?

f) How Free Flow Speed (FFS) is estimated from Basic Free Flow Speed (BFFS) for basic freeway segments?

g) What are the MOEs considered while estimating capacity and LOS of both classes of two-lane highways?

Question 2 (14 marks)

a) A four lane urban freeway (two lanes in each direction) is located in rolling terrian. The traffic stream consists of cars, buses and lagre trucks (no recretional vehicles). A weekday directional peak-hour volume of 2200 vehicles (familiar users) is observed, with 0.85 PHF. If a level of service no worse than C is desired, determine the maximum number of large trucks and buses that can be present in the peak-hour traffic stream. Assume FFS equals 105 Km/h.

b) 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 3 (15 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°.

b) 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).

PART II (Structural Design)

Question 4 (16 marks)

1- Discus with net sketches the types of underground drainage? Illustrating the conditions and specification of trench drains and filter?

2- Draw a plane to illustrate the joint system you recommended at the intersection of 4-lanes and 2-lanes concrete roads? Indicating the different types of joints and their spacing in the plan? Giving a detailed drawing for each type of joint illustrating their suitable reinforcement and function?

3- In the field a sand cone test was performed on the above soil, determine the maximum dry density and moisture content for this compacted soil if the results of sand cone test were as follow:

- weight of sand that fill the before performing the test = 57 lbs
- weight of sand that fill the after performing the test = 25 lbs
- weight of sand that fill the cone = 18 lbs
- weight of excavated soil = 20 lbs
- oven-dry weight of excavated soil = 15.5 lbs
- unit weight of calibrated sand = 97.3 pcf

a) Discuss the relative compaction for this soil if the laboratory dry density was 121.2 pcf?

b) Calculate zero air voids density at the given moisture content if the specific gravity was 2.6?

c) Calculate the dry density in the case of 70% saturation degree?

d) Determine the fully saturated moisture content as well as the moisture content at 70% saturation degree for this compacted soil?

Question 5 (17 marks)

1- The grain size analysis of a subgrade soil as the following:

Sieve NO.	4 (4.75mm)	10 (2mm)	40 (0.425mm)	60 (0.25mm)	100 (0.15mm)	200 (0.075mm)	L.L	P.L
% passing	60	56	30	19	13	10	22	19

a) Classify the above soil according to AASHTO and Unified system then determine the suitable compactor type for this soil?

b) If the previous soil used in a surface mixture, determine the approximate value for bitumen content in the mixture?

c) Design a flexible pavement constructed above this soil under a heavy traffic?

d) Calculate the vertical stress and deflection at the bottom of the calculated pavement thickness under a dual wheel load of 28000 lbs per wheel, spacing of 25 inch , pt of 95 psi , Elastic modulus for subgrade = 4000 psi.

2- Give the following data for two aggregates A and B

Sieve size	#4	#10	#40	#200
%passing A	100	100	85	60
%passing B	80	60	40	30

What is the required percentage of each of the above aggregates in the blend that should have the following characteristics, G.I=12, L.L=60, P.L=40

Question 6 (12 marks)

1- Give a brief note for each of the following:

- Stone matrix asphalt (SMA) purpose, advantage and disadvantage.
- Cut-back asphalt.
- Syboult and Float tests.
- Determine the voids in the mineral aggregate in bituminous mixtures.
- Plate loading test