Minufiya University
Faculty of Engineering
Civil Engineering Dept.
Final Examination, May 2015

Highway Engineering
4th Year
Time Allowed: 3 Hours
Date: 23/5/2015

Answer all questions and assume any missing data
Questions in three pages

PART I (Geometric Design)

Question (1) *(20 marks)*

a) Derive the equilibrium equation: $e + f_s = V^2/127R$

b) Explain with illustrations the passing sight distance and the factors used in its derivation.

c) What are the factors influencing the longitudinal grades of roads?

d) Define the following cross section elements and discuss their functions:

- Shoulder
- Median
- Curb

e) Explain using appropriate sketches the reasons for:

- Transition curves; and
- Pavement widening on horizontal curves.

As the radius of a horizontal curve increases, what happens to the values of both these parameters?

Question 2 *(12 marks)*

a) Calculate the desirable stopping sight distance for a segment of 2-lane, 2-way road with 80km/h design speed. Perception and brake reaction time is 3 sec, and longitudinal grade is +2.5%. (assume skid friction factor is 0.30)

b) Use the calculated stopping sight distance in "a" to determine whether 90 km/h design speed is safe on a horizontal curve located on this road segment or not. The degree of curve is 6°, deflection angle is 19°, rate of superelevation is 5%, and the distance between an existing building located in the inner side of the curve and road centerline is 9.5m. (Assume lane width = 3.5 m, and shoulder width = 2 m).

c) Use data above to draw to a reasonable scale the progress of pavement edges if it is achieved by rotation around the centerline (Assume q=1.5 %, A_{min} = 150).

Question 3 *(13 marks)*

a) A crest vertical curve of 400m length is used to connect two grades of G1= +2% and G2= -1%. The station and elevation of the highest point is 3+75 and 40.00m respectively. Calculate the design speed on this curve and the elevation on the curve at station 3+48.

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)

PART II (Structural Design)

Question 4 *(18 marks)*

a) Discuss in details the effect of gradation on the stability of asphalt mixtures?

b) What are the types of bases used in flexible pavement? Illustrating the characteristics of the aggregate used in base course?

c) Talk about the construction methods of surface layer in flexible pavement? Illustrating its functions?

d) Illustrate briefly the all methods for checking the dry density in the field?

e) Compare between the CBR test and the Plate loading test?

f) The grain size analysis of three subgrade soils is as the following:

soil	3/8"	No4 4.75	No.10 2.0	No.40 0.425	No.60 0.27	No.100 0.15	No.150 0.1	No.200 0.075	No.270 0.035	No.350 0.025	L.L	P.I
1	100	100	100	97				55			62	12
2	100	100	100	72	50	36	16	6			20	NP
3	100	100	100	100	85	60	40	25	15	5	33	6

1. Classify the three soils according to AASHTO System illustrating the (GI) values?
2. Classify the soils 1 and 3 according to Unified System?
3. Classify the soil 3 only according to FAA System?
4. Discus with net sketches the types of underground drainage? Calculating the conditions and specifications of trench drains and filter suitable for subgrade soil number 3?

Question 5 *(15 marks)*

a) Talk about the following points

1. Properties of mineral aggregates?
2. Engler test and Float test?
3. Different stabilization types of subgrade soil?
4. Cut back asphalt and emulsions asphalt?
5. Determination of approximate value of bitumen content?

b) A test hole (6 inch diameter and 8 inch depth) was made in compacted subgrade soil of 2.2 gm/cm^3 wet density and 7% moisture content and 2.65 specific gravity. It is required to determine:

1. The dry density and saturated density for the pavement section.
2. The zero air voids density the pavement section.
3. Void ratio and porosity for this soil.
4. The saturated moisture content for this compacted soil.

c) A particular aggregate combination used in asphalt mix contains 40% course aggregate (Gs= 2.64), 53% fine aggregate (Gs =2.80) and 7% filler (Gs = 2.86). The asphalt cement of (Gs = 1.03) was used by 6% from the weight of total mixture. The weight of mixture in air =1225 gm and 670 gm in water calculate:

1. The percent of voids in compacted mineral aggregates?
2. The theoretical specific gravity of the compacted specimen?

Question 6

(12 marks)

a) 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?

b) Calculate the vertical stress and deflection at the bottom of 12 inch flexible pavement thickness under a dual wheel load of 28000 Ibs per wheel, spacing of 25 inch , tire pressure of 95 psi , Elastic modulus for subgrade = 4000 psi.

c) A pavement was designed to survive 15 years with a starting and terminal serviceability of 4.2 and 2 respectively for a final total number of 2.0 x 107 ESAL (considering the traffic level having a growth rate of zero), the sub grade Mr is 10000 psi. After 10 years the pavement serviceability found to be 2.4. Estimate the actual number of repetitions based on measured PSI, when the pavement completes the design life of 15 years. Knowing that : R = 95% , So = 0.35

With our best wishes