UNIVERSITY OF TECHNOLOGY
Building and Construction Eng. Dept.
Final Exam– 2015 / 2016 (First Attempt)

Subject : Airports Engineering — Class: 4th
Branch : Highways & Bridges — Time : 3 Hours
Examiner : Asst. Prof. Dr. Karim Al Helo — Date : 14th, June, 2016

Note: Attempt FIVE of the following questions.

Q1: a: What is the program of Federal Aviation Administration FAA include? *(5 marks)*

b: What are the Revenues and Expenditure in U.S. Airports? *(5 marks)*

c: Show with drawings the influence of aircraft design on cost of travel, absolute power, speed, and seat. Mile/hour. *(5 marks)*

d: The length of the runway is designed to cover FOUR cases of takeoff and landing, What are these cases? *(5 marks)*

Q2: a: What are the weight component of aircraft. *(5 marks)*

b: The demand - Capacity analysis should cover SIX forecasting items, State them briefly. *(5 marks)*

c: Determine the size (diameter), discharge, velocity of water, slope of pipe, and the end level for line segment of **60 acres** drainage; average runoff coefficient equals **0.38,** if you know the following:

Area	Distance (ft)	Slope %
Over pavement	650	0.8
Over turf	3600	1.2

Use **5** years curve in *Fig. 10.2*, assume **n** Manning= **0.015, c** for turf=**0.30** and **c** for pavement = **0.90.** The inlet level is ***(20 ft above the MSL)*** and the pipe length =3,500 ft. *(10 marks)*

Q3: a: What are the five principal imaginary surfaces to protect airspace around airport? *(5 marks)*

b: What is the meaning of the VFR and IFR and when they are used? *(5 marks)*

c: An airport pavement to be designed for the traffic mix below. Convert the traffic to equivalent DC-8-61 departures.

Note: to convert from dual wheel to dual tandem use factor equals **0.6**

Aircraft wheel configuration	Departure R	Load per wheel lb
CV-880 (dual tandem)	12,000	20,000
DC-9-32 (Dual wheel)	10,000	25,000
DC-8-61 (dual tandem)	1,500	40,000

(10 marks)

Q4: a: The nautical mile is the distance equals the length of the arc facing central angle of ..... minute on the latitude line named ..... or latitude number..... The nautical mile equals.....meters. *(5 marks)*

b: One or more of five conditions requires installing visual approach slope indicator system (VASIS) to the runway, State these conditions. *(5 marks)*

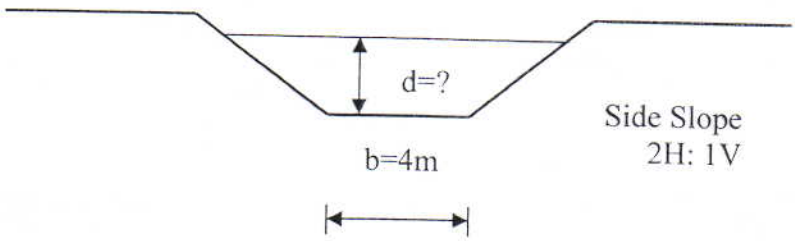
c: Use *Fig. 10.10* and find the thickness of 1. Sub base, 2. Base, and 3. Pavements for primary traffic area and wheel load of **60K** if you know that the thickness factor equals **1.15** and: CBR for Sub grade = **4**, for Sub base= **10**, and for Base = **34** *(10 marks)*

Q5: a: Draw and describe three types of runway configuration including the direction and numbering of each runway. *(5 marks)*

b: What is the functions of the jointing in the concrete pavement? What are the three various types of joints in rigid pavement *(5 marks)*

c: For the shown trapezoidal channel, find **d** for the cross section to carry a discharge of **9m^3/sec** at velocity of **0.75 m/sec** if the bed width **b= 4m**. Then find the real discharge using the following equation if you know the bed slope is **10cm/km** and **Manning's n =0.015**

$$Q = \frac{A\, R^{2/3}\, S^{1/2}}{n}$$



(10 marks)

Q6: a: Use figure 10.13 to find the thickness of concrete pavement if the allowable working stress of concrete is 500 psi, the aircraft weight is 150,000 lb. And k value equals 100 pci. *(5 marks)*

b: What are the three functions of subsurface drainage? Show briefly the material used for and the construction method. *(5 marks)*

c: Calculate the discharge **(Q)** for following inlets:

i. Law head of **c=3, L=13 ft,** and **H= 0.4 ft.** *(5 marks)*

ii. High head of **c=0.5, A=5 sq .ft, H=1.6 ft and g=32.2 ft/sec^2** *(5 marks)*

(Good Luck)

Solutions

Q1: a: The program of federal Aviation adminstration includes the following:

1- Safety regulations
2- Research and developments
3- Air navigation facilities (construction, maintenance, ...)
4- Air space and Air Traffic, Management, Towers, routes ....)
5- Airport planning and development programs (types and cost of airport ...)
6- Regestration and Recordation (engines, aircraft ownership)
7- Civil aviation abroad (Technical & training)
8- Other programs (technical materials, guarantee program)

Q2

a: The weight components of Aircraft are:

1- Empty operating weight is constant.
2- Zero fuel weight
3- Maximum takeoff weight
4- Maximum ramp weight > max takeoff weight by the weight of fuel required for taxiing
5- Maximum landing weight < max takeoff weight by weight of fuel (burned)

Q2: C

$$T_t = \frac{1.8(1.1-0.3)(3600)^{1/2}}{(1.2)^{1/3}} = \frac{86.4}{(1.2)^{1/3}} = 81.3 \text{ min}$$

$$T_p = \frac{1.8(1.1-0.9)(650)^{1/2}}{(0.8)^{1/3}} = 9.89 \text{ min}$$

Total time = 81.3 + 9.89 = 91.19 ≃ 91 min

From Fig 10.2 : duration of 91 min ⇒ rainfall intensity = 1.25 in/hr

Rainfall $Q = CIA$

$= 0.38(1.25)(60) = 28.5$ cfs

Diameter = 46"

real $Q = 33$ cfs > 28.5 safe

slope = 0.006

End level = 3500 20 − (3500 × 0.0006)

= 20 − 2.1 = 17.9 ft above MSL

Q3 a:

The imaginary surface are:

1- Primary surface : longitudenally centered on the runway, extended 200 ft in each directions.
2- Approach surface : inclined plane from the end of primary surface
3- Horizontal Surface : 150 ft above airport elevation.
4- Transition Surface : plane of slope 7:1 extending upward and outward from primary surface
5- Conical Surface : inclined at slope 20:1 extending upward and outward from horizontal surface

Q3 b:

VFR: Visual flying rules. It is used when weather condition are good enough and when traffic densities are low to permit the pilot to depend on vision

IFR: INstrument Flying rules. It used when the visibility of the ceiling (height of clouds above ground level) falls below the range of VFR

Q3: C

$$\log R_1 = \log R_2 \left(\frac{W_2}{W_1}\right)^{1/2}$$

$$\log R_1 = \log(1 \times 12000) \cdot \left(\frac{20000}{40000}\right)^{1/2}$$

$$= 4.0792\ (0.7071) = 2.884$$

$$R_1 = 766$$

$$\log R_1 = \log (0.6 \times 10000) \left(\frac{25600}{40000}\right)^{1/2} =$$

$$\log R_1 = 3.778 \times (0.7906) = 2.987$$

$$\therefore R_1 = 970$$

Total = 1500 + 766 + 970 = 3236 departures

Qu a:

The nautical mile is the distance equals the length of the arc facing central angle of 1 minute on the latitude line named equater or latitude No Zero. The nautical mile equals 1852 meters.

Q4.

b:

Used when:

1- Runway is used by turbojet aircraft
2- Pilot may have difficulty in judging the final approach because of inadequate visual reference
3- There are serious hazards in approach area
4- Serious hazard would occur (undershooting)
5- Turbulance because of terrain or meterological conditions

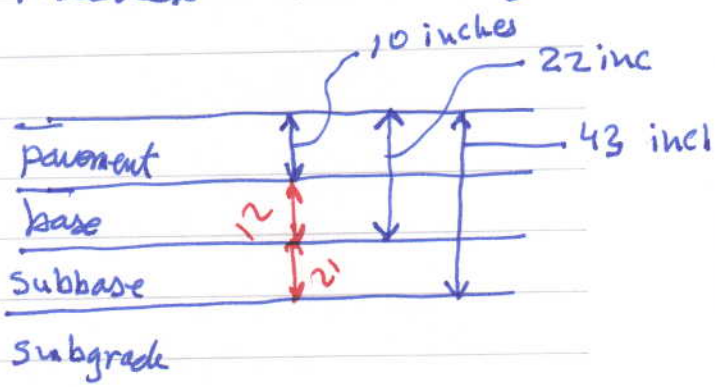
Q4 C:

For subgrade CBR = 4 ⇒ Thickness above subgrade = 37 in

$37 \times 1.15 = 42.55$ inches ≈ 43 inches

For subbase CBR = 10 ⇒ Thickness = 22 inches

For base CBR = 34 ⇒ Thickness = 10 inches



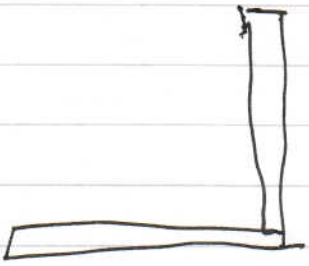
Subbase thickness
= 43 − 22 = 21 inches

base = 22 − 10 = 12 inches

pavement = 10 inches

Q5 a- شروع بأطوازه single

double Parallel



double perpendicular

Q5 b-
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To reduce the effect of

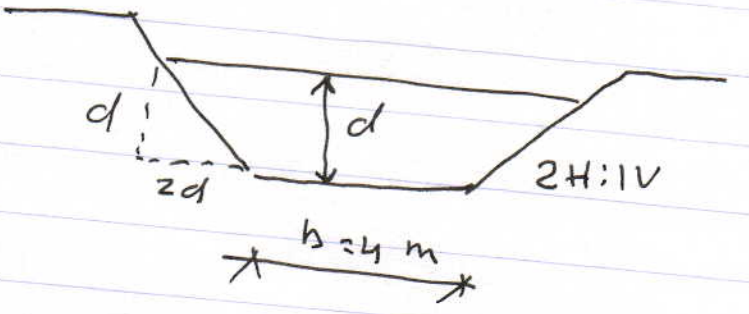
1- Variation of Temperature

2- Moisture content

Types of Joints

1- Expansion joint : provide space for expansion and used between intersecting, adjacent to structure
2- Construction joint: provide control cracking
3- Construction joint : between two slabs constructed at different time

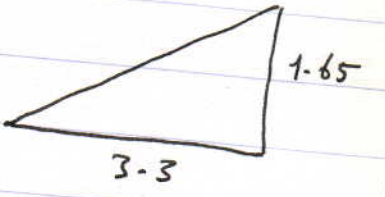
Q5 c



$$A = \frac{Q}{V}$$

$$A = \frac{9\ m^3/sec}{0.75\ m/sec} = 12\ m^2$$

$$\text{Area} = 12\ m^2 = 4d + 2\left(\frac{2d \times d}{2}\right)$$



$$= 12\ m^2 = 4d + 2d^2$$

By trial and error

$$d = 1.65\ m$$

$$R = \frac{A}{P}$$

$$P = b + 2\sqrt{(3.3)^2 + (1.65)^2}$$

$$= 4 + 2\sqrt{10.89 + 2.72}$$

$$= 4 + 2\sqrt{13.61} = 4 + 2(3.69) = 11.38\ m$$

$$R = \frac{12}{11.38} = 1.054$$

$$S = \frac{10\ cm}{100000}$$

$$S = \frac{1}{10000}$$

$$S^{\frac{1}{2}} = \frac{1}{100}$$

$$Q = \frac{12 \times (1.054)^{2/3} \left(\frac{1}{100}\right)}{0.015} = 8.432\ m^3/sec$$

Q6 a = from curve

thickness = about 11 inches

Q6 b
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Function of subsurface drainage

1- drain and upgrade wet soil masses
2- Intercept and divert subsurface flow
3 - lower and control the water table

Q6 c

I- $C = 3$, $L = 13$ ft , $H = 0.4$ ft

$$Q = CLH^{3/2} = 3(13)(0.4)^{3/2}$$

$$= 9.86 \text{ cfs}$$

II $C = 0.5$, $A = 5$ sq.ft , $H = 1.6$ ft

$$Q = CA\sqrt{2gH} = 0.5(5)\sqrt{2 \times 32.2 \times 1.6}$$

$$= 30.54 \text{ cfs}$$