II.A. *Ecological processes (e.g., interaction of plant/animal/microbial communities, constructed wetlands, stream restoration)*

Vertical transport of pathogens, out of the root zone, from surface application of manures depends mostly on:

    (A) the amount of macro pores and micro pores in the soil matrix

    (B) the amount of microorganisms in the manure

    (C) the size of the microorganisms

    (D) the cation exchange capacity of the soil

Correct answer (A)

Reference: *Soil and Water Conservation Engineering 6th edition* by Fangmeier, p. 80, and other soils science textbooks. Physical transport of pathogens in soils is a function of the macro pores in the soil transported by water.

II.B. *Erosion control and soil stabilization (e.g., risk analysis, conservation practices, basin design)*

The horizontal interval (HI) in meters for conservation terraces on 5% land in northern Iowa given Y = 0.9 is most nearly?

    (A) 2

    (B) 10

    (C) 20

    (D) 40

Correct answer (D) 40 meters

Reference: ASABE Standard S268.4, section 3.1.1.3 or *Soil and Water Conservation Engineering 6th edition* by Fangmeier, p. 167

$$HI = VI / S = [(5 \times 0.21) + 0.9]/0.05 = 39 \text{ M}$$

II.C. *Hydrology (e.g., precipitation, infiltration, runoff, flood routing, ground water, hydrographs, ET)*

A municipality is in need of assistance in the design of a water control structure. The designer is using a 50 year-24 hour storm rainfall depth of 4.0 inches. The probability of the design storm being exceeded in any given year is most nearly:

    (A) less than 1%

    (B) 2%

    (C) 50%

    (D) 100%

Correct answer (B) 2%

Reference: *Soil and Water Conservation Engineering* 6th edition by Fangmeier, p. 38

$$T = 100/P$$

$(50/100)^{-1} = 100/50 = 2.$ This is commonly referred to as a 2% probability of occurrence.

II.E. Nutrient management/loading rates in soils (e.g., budget, CNMP principles, crop nutrient uptake, vegetative treatment areas)

The amount of nitrogen, in pounds/ac, that a ten ton per acre hay crop (total dry harvested weight) of Bermudagrass removes is most nearly:

(A) 50

(B) 200

(C) 250

(D) 350

Correct answer (D) 350 lbs/ac

$$10 \text{ tons} \times (2{,}000 \text{ lbs/ton}) \times 0.0188 = 376 \text{ lbs/ac}$$

Reference: *National Engineering Handbook. Part 651, Agricultural Waste Management Field Handbook*, Chapter 6, Table 6-6

II.F. Open-channel hydraulics (e.g., natural and constructed channels, energy dissipation structures, partially filled conduits, weirs, flumes)

An open channel is being designed using the tractive force method. The straight channel is to be lined with 50 mm gravel (on a 2% slope). The critical shear in Pascals is most nearly?

(A) 16

(B) 32

(C) 64

(D) 96

Correct answer (B) 32 pascals

Reference: *Soil and Water Conservation Engineering 6th edition* by Fangmeier, p. 119

II.F. Open-channel hydraulics (e.g., natural and constructed channels, energy dissipation structures, partially filled conduits, weirs, flumes)

A 10 foot wide rectangular concrete channel (Manning's n = 0.01) is to be built to convey water. The design discharge is 100 cfs and flows at a velocity of 7.34 ft/sec. The slope in percent grade (%) of this channel is most nearly?

(A) 0.18

(B) 0.22

(C) 1.36

(D) 4.72

Correct answer (B) 0.22%

Reference: *Engineering Field Handbook,* chapter 3, eq. 3-15

$V = 1.486 / nr^{2/3} S^{1/2}$

$A = Q/V = 100 / 7.34 = 13.6$ sq ft

$Dm = A/T = 13.6 / 10 = 1.36$ ft

$r = A/WP = 13.6 / (1.36 + 10 + 1.36) = 1.07$ sq ft / ft

$S = [Vn /(1.486 \, r^{2/3})]^2$

$S = [7.34 \times 0.01 / (1.486 \times 1.07^{2/3})]^2 = 0.0022$ or 0.22%

II. H. Surface and Subsurface drainage

A corrugated plastic tubing main is used to drain six (6) laterals; each lateral is 1000 m long and the lateral spacing is 30 m. The design slope of the main is 1 m / 100 m and the drainage coefficient is 10 mm/day. The minimum standard size of the inside diameter of the mainline in mm is most nearly:

(A) 102

(B) 152

(C) 203

(D) 254

Correct answer (C)

Reference: *Soil and Water Conservation Engineering* by Fangmeier, p. 322, figure 14-9

Read nomograph correctly using 10 mm coefficient and 1% slope:
1000 m × 6 × 30 m / 10,000 = 18 ha

Common mistakes:

(A) 1000 × 30 m / 10000 = 3 ha. Read nomograph using 10 mm coefficient and 1% slope.

(B) 1000 × 30 m / 10000 = 3 ha. Read nomograph using 10 mm coefficient and 0.1% slope.

(D) 1000 m × 6 × 30 m / 10000 = 18 ha. Read nomograph using 13 mm coefficient and 1% slope.

II. I. Engineering Surveying Principles (e.g. topographic, stakeout, GPS, cuts and fills, interpretation)

Given the following survey notes what is most nearly the elevation at station 2+00?

Station	Back Sight (BS)	Height of Instrument (HI)	Fore Sight (FS)	Elevation (Elev)
TBM-1	3.23			100.00
TP-1	7.54		4.87	
TP-2	8.56		6.43	
0+00			4.6	
1+00			7.2	
2+00			9.5	
3+00			5.0	

Station				
TP-3	12.11		8.51	
TP-4	4.30		9.50	
TBM-1			6.43	

A. 86.7

B. 96.9

C. 98.5

D. 102.1

Station	Back Sight (BS)	Height of Instrument (HI)	Fore Sight (FS)	Elevation (Elev)
TBM-1	3.23	103.23		100.00
TP-1	7.54	105.90	4.87	98.36
TP-2	8.56	108.03	6.43	99.47
0+00			4.6	103.4
1+00			7.2	100.8
2+00			9.5	98.5
3+00			5.0	103.0
TP-3	12.11	111.63	8.51	99.52
TP-4	4.30	106.43	9.50	102.13
TBM-1			6.43	100.00

II.J. Soil mechanics principles (e.g., forces, bearing capacity, shear strength, compaction, slope stability)

ASABE Standard S526.3 defines silt as a soil separate consisting of particles between 2 and 50 μm (micrometers) in diameter, using what soil classification system?

(A) AASHTO

(B) FAA

(C) USCS

(D) USDA

II.J. Soil mechanics principles (e.g., forces, bearing capacity, shear strength, compaction, slope stability)

Using the Unified Soil Classification System, what group symbol is given to a soil with the following description?

- plasticity index of 15
- liquid limit of 43
- 60% of the soil passes the #200 sieve
- minimal organic matter

(A) ML
(B) CH
(C) CL
(D) SC

II.K. Soil physics principles (e.g., infiltration, moisture content, soil physical properties, shrink-swell)

As part of a geotechnical analysis for the construction of a runoff retention pond in Texas, it is determined that the soil material to be used for the earthen liner is highly calcareous and is classified as a CL (Unified Soil Classification System) soil. The soil amendment able to swell up to 10-15 times its dry volume when exposed to water and able to decrease the permeability of the soil is:

(A) bentonite
(B) soda ash (Na_2CO_3)
(C) sodium tripolyphosphate (STPP)
(D) tetrasodium pyrophosphate (TSPP)

II.K. Soil physics principles (e.g., infiltration, moisture content, soil physical properties, shrink-swell)

Given the following data for a soil sample, the moisture content (dry basis) of the sample is most nearly:

Mass of sample can	16.09 g
Mass of sample can and wet soil	31.32 g
Mass of sample can and dry soil	29.28 g

(A) 7.0%

(B) 12.7%

(C) 13.4%

(D) 15.5%

Correct answer (D) 15.5%

Reference: *ASABE Standards,* specifically EP419.1, S501, and S358 in addition to various other references.

%MC (dry basis) = [H_2O mass/dry matter mass] × 100%

[(31.32 − 29.28) g H_2O / (29.28 − 16.09) g dry soil] × 100% = 15.47% ≈ 15.5%

II.K. Soil physics principles (e.g., infiltration, moisture content, soil physical properties, shrink-swell)

Determine the saturated water content (%) of the soil described below, which is to be compacted to 95% of maximum standard proctor density. It is most nearly:

- Standard Proctor Maximum Dry Density: 101 pcf
- optimum water content: 19%
- in situ water content 21%
- coefficient of permeability: 1×10^{-6} cm/s
- specific gravity of soil solids: 2.70

(A) 18

(B) 20

(C) 25

(D) 28

Correct answer (D) 28%

Reference: *Engineering Field Handbook,* Chapter 4, page 4-7

$$W_{sat},\% = \left(\frac{\gamma_{water}}{\gamma d} - \frac{1}{G_s} \right)(100) \Rightarrow W_{sat},\% = \left(\frac{62.4}{0.95(101)} - \frac{1}{2.70} \right)(100) = 28\%$$

II.L. Sediment processes (e.g., detachment, transport, deposition)

A flood control reservoir is being designed for a 40-square-mile watershed. The average annual soil loss is 8 tons/acre. The design includes flood storage of 350 acre-feet, sediment storage of 127 acre-feet and permanent pool storage of 300 acre-feet. The sediment delivery ratio is expected to be 17% with an average density of 127 lbs/cubic foot. The life of the reservoir based on sediment capacity in years is most nearly:

(A) 10

(B) 25

(C) 35

(D) 50

Correct answer (A)

Reference: *Soil and Water Conservation Engineering* by Fangmeier, et al, 6th edition, p. 149-150

40 sq mile × 640 acres/sq mile × 8 tons/acre/year × 0.17 delivery ratio × 2000 lbs/ton ×

(1 acre / 43,560 ft^2) × (1 /127 lbs/ft^3) = 12.6 acre-ft per year

Planned sediment capacity is 127 acre-ft.

127 acre-ft / 12.6acre-ft / year = 10.1 years