Final Term Exam Solution

CIE221 *Hydrology & Irrigation Engineering*

Question (1): *(c1-a2, c1-a3, c1-b1, c1-b2, c12-b1 and c12-b2) (12 Marks)*

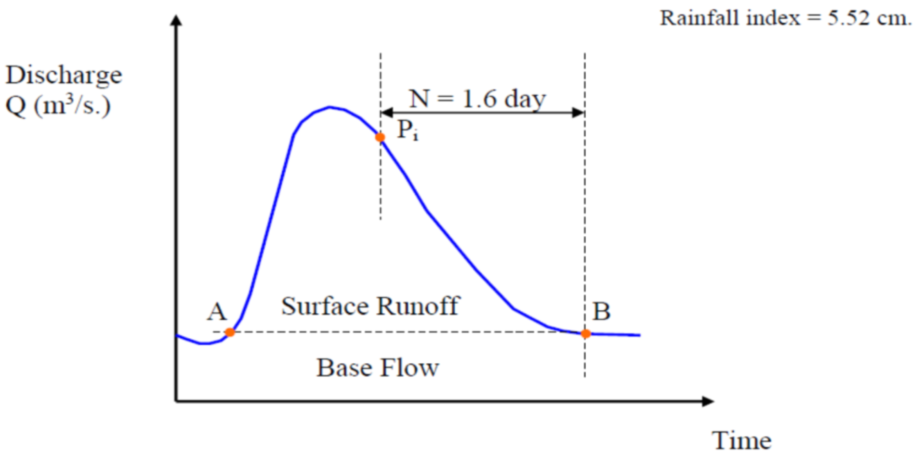
1 – T   2 – T   3 – F   4 – T   5 – T   6 – F   7 – T   8 – F   9 – F   10 – T   11 – T   12 – F   13 – T   14 - F

15 – T   16 – F   17 – T   18 – F   19 – F   20 – T   21 – F   22 – T   23 – T   24 – F   25 - T

Question (2): *(c1-a2, c1-a3, c1-b2 and c12-b2) (15 Marks)*

1 - Rainfall with a value of 8.5 and 7 cm occurred during successive periods of 8 hours and over an area of 35 km^2 and produced the following hydrograph at the point of discharge of the catchment, calculate the rain increase and the value of the index Φ.

Time from Rainfall start (hr)	-4	0	8	16	24	32	40	48	56	64	72
Total Runoff (m^3/s)	12	10	26	52	42	32	24	18	14	10	10



$$N = 0.83 * A^{0.2} = 0.83 * 35^{0.2} = 1.69\ day = 40\ hr$$

نحدد نقطة B ونلاحظ من الجدول انها عند t = 64 .

نحدد نقطة A ونلاحظ من الجدول انها عند t = 0 .

نقطة الذروة تكون عندما t = 16 .

نقطة الانقلاب الثانية تقع بين t = 16 و t=24 اذن نفرض نقطة الانقلاب عند t = 20.

نحسب قيمة N مرة أخرى : N = 64 - 20 = 44 hr .

وهى قيمة منطقية أكثر من N = 40.

نصل النقطة A و B بخط مستقيم لفصل التيار القاعدى وقيمته 10 m^3/s .

نحسب قيم الجريان السطحى عند كل زمن وذلك بطرح الجريان القاعدى من الجريان الكلى خلال الفترة المحددة من 0 الى 56 ساعة.

Time from Rainfall start (hr)	0	8	16	24	32	40	48	56	64
Total Runoff (m^3/s)	0	16	42	32	22	14	8	4	0

نحسب حجم الجريان السطحى ومنها عمق الجريان :

Surface Runoff Volume

=8*60*60*0.5[(0+16)+(16+42)+(42+32)+(32+22)+(22+14)+(14+8)+(8+4)+(4+0)] = 3974400 m^3.

Depth of Runoff = 3974400/ 35*10^6 = 0.11355 m = 11.36 cm

Total Rainfall = 7 + 8.5 = 15.5 cm   نحسب الأمطار الكلية

Φ index = (15.5 – 11.36) / 72 = 0.0575 cm / hr

2 - A rainstorm with a depth of 15 cm and a direct runoff of 7.5 cm. If the distribution of the rainstorm is as shown below, calculate the Φ index of the rainstorm for the rainstorm.

Time from the beginning (hr)	1	2	3	4	5	6	7	8
Increase in rainfall every hour (cm)	0.6	0.9	1.9	2.7	2.1	1.8	1.1	0.7

The total Infiltration = 15 – 7.5 = 7.5 cm

Assume t_c = 8 [Increase rainfall time] (**First trial**)

Φ = 7.5/8 = 0.9375 cm/hr (This value is greater than the rain increase for the first 2 hours and the eighth hour, so the value of t_c = 5 hours).

The total Infiltration = 15 – 7.5 – 0.6 - 0.9 – 0.7 = 5.3 cm

Φ = 5.3/5 = 1.06 cm/hr O.K.

3 - Use Blaney – Criddle formula to calculate PET for the duration of April to September, which grows wheat to a particular area located at latitude 30 degrees north and the monthly average temperature as follows:

Month	Apr.	May	Jun.	Jul.	Aug.	Sep.
Temperature (° C)	20	29	32	35	33	27
K for the crop	0.6	0.65	0.7	0.75	0.75	0.65
% of daily hours	8.80	9.65	9.95	10.20	9.80	9.10

$$F = P_h \frac{T_f}{100}$$

$$PET = 2.54 * K * F$$

Month	Apr.	May	Jun.	Jul.	Aug.	Sep.
Temperature (° C)	20	29	32	35	33	27
Temperature (° F)	68	84.2	89.6	95	95.4	80.6
% of daily hours Ph	8.80	9.65	9.95	10.20	9.80	9.10
F	6	8.1	8.9	9.7	9.3	7.3
K for the crop	0.6	0.65	0.7	0.75	0.75	0.65
PET (Cm)	9.12	13.41	15.85	18.46	17.8	12.11

PET = 86.8 cm.

Question (3): *(c1-a2, c1-a3, c1-b1 and c12-b1) (18 Marks)*

1 - A crop in a sandy loam soil containing 30% stone, has an effective root depth of 0.40 m. Find the refill depth if RAW = 45 mm/m. If ε=0.70 and Θ_{FC} =0.31 find the refill point and the wilting point. If the Consumptive use is 250 m^3/fed./month and A_s = 1.4, calculate the maximum period between two watering during a certain period from the growing stage of a certain crop and the efficiency of the irrigation if the delivered water is 120m^3/fed.

RAW without stones = 0.7 * 45 = 31.5 mm/m

RAW depth = 31.5 * 0.40 = 12.6 mm

AWC depth = RAW/ε = 12.6/0.70= 18 mm

RAW %= 12.6/400 = 3.15%

RAW = Θ_{FC} - Θ_{Rp} Θ_{Rp} = 31% - 3.15% = 27.85%

AWC %= 18/400 = 4.50%

AWC = Θ_{FC} - Θ_{wp} Θ_{wp} = 31% - 4.50% = 26.50%

U= 250 m^3/fed./month

$$U = \frac{250 * 100}{4200 * 30} = 0.19 \frac{cm}{day}$$

Readily available water,

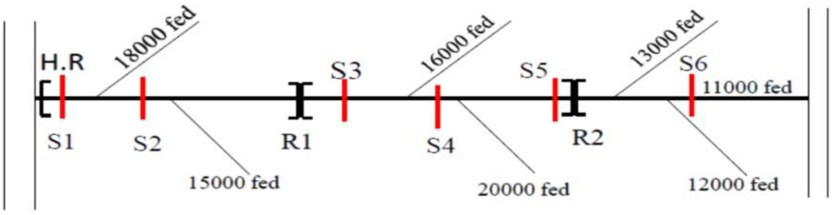
$$D = 0.01 * E_d * (\theta_{FC} - \theta_{RP}) * A_s * 0.5$$
$$D = 0.01 * 40 * (31 - 27.85) * 1.4 * 0.5 = 0.88\, cm$$

$$Frequency\ of\ Irrigation = \frac{Readily\ Available\ Water\ Content\ (cm)}{Consumptive\ Use\ \left(\frac{cm}{day}\right)}$$

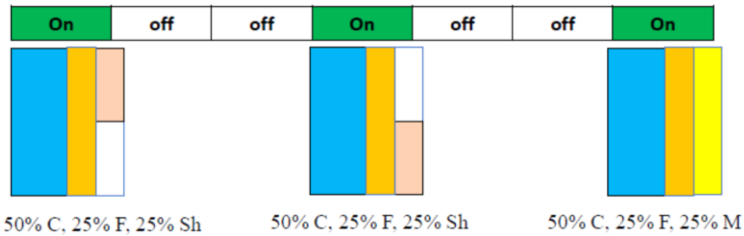
$$F = \frac{D}{U} = \frac{0.88}{0.19} = 4.6\ days = 4\ days$$

$$\tau = \frac{F * U}{Q} = \frac{4 * 250/30}{120} = 27.7\ \%$$

2 - For the shown figure, the area served by the main canal 105000 feddans, which is cultivated by 40 % Cotton (18 days,420 m^3/fed/watering), 25% Sharaki (32 days,760 m^3/fed/watering), and 25% fruits (19 days,420 m^3/fed/watering). Calculate the irrigation field duty, distributing canal, branch canal, main canal water duties Also, it is required to estimate the area served and the canal discharge at sections 1, 2, 3, 4 and 5 Considering that the compensation factor 20%.



40% Cotton, 25% Sharaki, and25 % fruits
Cotton (18 days), Fruits (19 days) and Sharaki (32 days).
Type of rotation : 3 turn rotation, No of working period = 18/3 = 6 days



$$Field\ water\ duty, F.W.D. = \sum\left(\frac{\%of\ area\ used * water\ requirement\ of\ crop}{No.of\ working\ days * No.of\ division}\right)\ m^3/fed/day$$

$$Field\ water\ duty, F.W.D. = \frac{40*420}{100*6*1} + \frac{25*420}{100*6*1} + \frac{25*760}{100*6*2} = 61.33\ m^3/fed/day$$

*Water duty for distributary canal, D.W.D= 1.1 * 61.33 = 67.47 m^3/fed/day*
*Water duty for branch canal, B.W.D = 1.2 * 61.33 = 73.6 m^3/fed/day*
*Water duty for main canal, M.W.D = 1.3 * 61.33 = 79.73 m^3/fed/day*

Sec.	A	B	C	B+αA	C+αB	A+αC	Area Served	$Q_{M.C.}$ (m^3/s)
S1	33000	36000	36000	41940	42480	39480	42480	39.20
S2	15000	36000	36000	38700	42480	21480	42480	39.20
S3	0	36000	36000	36000	42480	6480	42480	39.20
S4	0	20000	36000	20000	39600	6480	39600	36.54
S5	0	0	36000	0	36000	6480	36000	33.22
S6	0	0	11000	0	11000	1980	11000	10.15

3 - A Main canal discharges 20 m^3/s, water surface slope 10 cm/km, Side slopes 1:1, 3:2. Check the canal water velocity if the water depth is 3.0 m and canal bed width is 6.0 m, Draw and estimate the expropriation limits.

$$A = b*y + t*y^2$$

$$A = 6*3 + 1.0*3^2 = 27\ m^2$$

$$V_{act} = \frac{Q}{A_{act}} = \frac{20}{27} = 0.74\ m/s. \quad o.k.$$

Assume bank width = 6.0 m
For a branch canal freeboard = 0.50 m
Bank height, h = 1.5 m
Area of cut = 1.15(bd+td^2)=1.15(6∗3.0+1.0∗3^2) =31.05m^2
Area of fill = 2(Rh+nh^2)=2(6∗1.5+1.5∗1.5^2)=24.75m^2
If area of cut > area of fill, spoil is needed.

Required area for spoil = 31.05 – 24.75 = 6.3 m^2

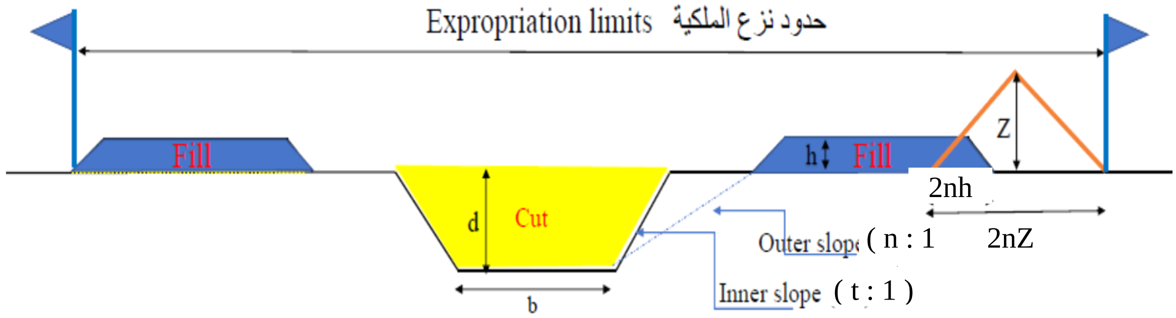
Area of spoil = A_{cut} - A_{fill} = $nZ^2 \; nh^2$

$6.3 = 1.5 * Z^2 – 1.5 * 1.5^2$

Z= 2.54 m < 5.0 m (one sides of spoil is needed)

Area of right spoil = $2*5^2 \; 2*1.5^2 = 45.5m^2$

Expropriation limits = 6 + 2(4.5*1.5 + 6) + (2*1.5*2.54 - 2*1.5*1.5) = 28.38 m



Question (4): *(c1-a2, c1-b2 and c12-b2) (15 Marks)*

1 - Calculate the wetness percentage of a fine-textured soil irrigated by drip with 6 drippers with a drainage of 12 liters/hour around each of the trees distributed on the corners of rectangles of dimensions 6 * 5.5 meters.

*- From the table for (q = 12L/hr) and (F) soil we find that (S_{ep}) = 2.0m.

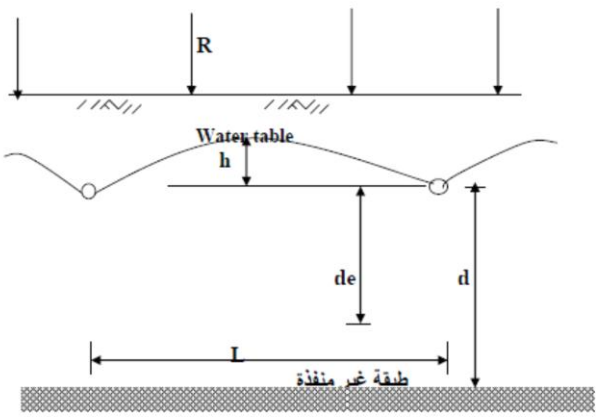
*- The average distance between the lines (S_2) which gives P_2=100% is 2.5m.

$$P = \frac{100 * n * S_{ep} * S_2}{S_r * S_t}$$

$$P = \frac{100 * 6 * 2.0 * 2.5}{5.5 * 6} = 90.91\%$$

2 - Calculate the distance between two lateral drains in covered drainage system as shown in the figure, knowing that:- Drainage Water Duty = 3 mm/day. - Minimum Depth of Drainage from Land Surface = 1.5 m. - Coefficient of Permeability = 0.16 m/day. - Depth of Pipe from Land Surface = 2.5 m. - Pipe Diameter = 25 cm. - Depth of Impermeable Layer from Land Surface = 7.5m .

d : بعد سطح الماء فى المصرف عن الطبقة الغير منفذه (شكل (7-14)).



*- R = 3mm/day = 0.003 m/day.

*- h = 2.5 -1.5 = 1.0 m.

*- r = 0.125 m.

*- k = 0.16 m/day.
*- d = 7.5 - 2.5 = 5.0 m.

$$L^2 = \frac{8 * k * h * d_e + 4 * k * h^2}{R}$$

$$L^2 = \frac{8 * 0.16 * 1 * d_e + 4 * 0.16 * 1^2}{0.003}$$

$$L = \sqrt{427 * d_e + 213} \qquad (1)$$

$$d_e = \frac{d}{1 + 6 * \left(\frac{d}{L}\right) * log\left(\frac{d}{u}\right)}$$

$$d_e = \frac{5.0}{1 + 6 * \left(\frac{5.0}{L}\right) * log\left(\frac{5.0}{0.393}\right)}$$

$$L = \frac{33.13 * d_e}{5.0 - d_e} \qquad (2)$$

*- By Trial & Error Method:

de	2.0	2.2	2.4	2.6	2.8	3.0
L (1)	32.66	33.95	35.18	36.38	37.53	38.65
L (2)	22.08	26.03	30.58	35.89	42.17	49.69
Error = L (1) - L (2)	10.58	7.92	4.60	0.48	-4.63	-11.04

*- d_e = 2.63 m.
*- L = 36.77 m.

3 – A piece of land (2250x1600) m is to be irrigated using the semi portable sprinkler system. The water demand for the proposed plants is 280 m^3/fed/turn (turn = 5 days) and the sprinkler influence circle equals 50 m. The wind is in the direction of long length. The Equivalent Sprinkler Water Depth = 9 mm/hr, Working Hours = 18 hrs and Overlay Between Circles % = 55% between sprinklers, 40% between Lines. It is required to Align the pipe system and Estimate the number of the sprinklers on each line.

$$area\ in\ acres = A = \frac{2250 * 1600}{4200} = 857\ Fed.$$

$$Water\ demand\ (mm) = 280 * \frac{1000}{4200} = 67\ mm$$

$$Spr.Wor.Hrs/mov. = \frac{67mm}{9\frac{mm}{hr}} = 7.44\ hr \approx 8hrs$$

$$Spr.Wor.Hrs/mov. = 8hrs + 1hr\ for\ moving\ the\ pipe = 9hrs$$

*- Number of Movement/Day = (Working Hours per Day / Spr. Wor. Hrs/mov.) = 18/9 = 2.
*- Number of Valves = Number of Days per Turn*Number of Movement/Day = 5 x 2 = **10 valves**.
*- Eeffective Distance Between Valves = 0.55*Diameter of Circle of Influence of The Sprinkler = 0.60*50 = 30.0 m.
*- Length of Sprinkler Pipe = 200 ms.
*- Proposed Number of Sprinkler Pipes Along the 1600 m side = 1600/200= **8**.
*- Effective Distance Between the Sprinklers = 0.4*45 = **18 ms.**
*- Number of Sprinklers Along the Sprinkler Pipe = 200/18 = 11.11≈**12 Sprinklers**
*- Proposed Branch Pipe Length = 30*2*5 =300 m.
*- Proposed Number of Branch Pipes Along the 2250 m side = 2250/300= 7.5 ≈ **8**.
*- Length of Branch Pipe = 2250/8 = 281 m.
*- Plot Dimension = 200*268.5 , Area of the Plot = (200*281)/4200 = **13.38 fed**.
*- Number of Plots = 8*8 = 64 plots.
*- Number of Sprinklers = 12*64=768 sprinklers.

Final Term Exam Solution

CIE305 ***Hydrology & Irrigation Engineering***

Question (1): *(c1-a2, c1-a3, c1-b2 and c12-b2)(12 Marks)*

1 – T 2 – F 3 – T 4 – F 5 – F 6 – T 7 – T 8 – F 9 – F 10 – T 11 – T 12 – F 13 – F 14 - F

15 – T 16 – F 17 – T 18 – F 19 – F 20 – T 21 – F 22 – T 23 – T 24 – F 25 - T

Question (2): *(c1-a2, c1-b1 and c12-b2) (15 Marks)*

1 - A cylinder of inner area 212 cm^2 is used to obtain a soil of length 28 cm in its natural state, if the moist soil sample weights 102 N and when oven dried weights 86 N, Determine:

(a) The percent of moisture content on volume basis.

(b) The percent of moisture content on dry weight basis.

(c) The apparent specific gravity of soil. (d) Equivalent depth to restore the soil moisture.

L = 28 cm, Area = 212 cm^2

Total volume = 28 * 212 = 5936 cm^3

W_t = 102 N, W_s = 86 N, W_w = 102 - 86 = 16 N.

$$V_w = \frac{W_w}{\gamma_w} = \frac{16 * 1000}{9.81} = 1631\ cm^3$$

$$\theta_v = \frac{V_w}{V_t} * 100 = \frac{1631}{5936} * 100 = 27.5\%$$

$$\theta_m = \frac{W_w}{W_s} * 100 = \frac{16}{86} * 100 = 18.6\%$$

$$A_s = \frac{W_s}{V_t * \gamma_w} = \frac{86 * 1000}{5936 * 9.81} = 1.47$$

$$d = 0.01 * D * \theta_m * A_s = 0.01 * 28 * 18.6 * 1.47 = 7.66\ cm$$

2- A cylinder of inner diameter 10 cm is used to obtain of soil sample of length 25 cm, if void volume in natural statue is 400 cm^3 and density is 1.96 gm/cm^3 and when dry density is 1.75 gm/cm^3, determine: -

(a) The apparent specific gravity of soil and soil porosity.

(b) The percent of moisture content on volume basis and on weight.

(c) Equivalent depth to restore the soil moisture.

Total volume = $\pi/4 * 10^2 * 25$ = 1963 cm^3

Vs = 1963 – 400 = 1563 cm^3 γ_d = 1.75 gm/cm^3

$$\gamma_d = \frac{W_s}{V_s}$$

Ws = 2735 gm

$$\gamma_s = \frac{W_s}{V_t} = \frac{2735}{1963} = 1.39\ gm/cm^3$$

$$n = \frac{V_v}{V_t} * 100 = \frac{400}{1963} * 100 = 20.4\%$$

$$W_t = 1.96 * 1963 = 3847\ cm^3$$

Ww = 3847 – 2735 = 1112 gm

$$\theta_m = \frac{W_w}{W_s} * 100$$

$$\theta_m = \frac{1112}{2735} * 100 = 40.6\ \%$$

$$\theta_v = \frac{V_w}{V_t} * 100$$

$$\theta_v = \frac{1112}{1963} * 100 = 56.65\%$$

$$d = 0.01 * D * \theta_m * A_s$$

$$d = 0.01 * 25 * 40.6 * 1.39 = 14.11\ cm$$

3 - It is required to calculate the water consumptive use during the period from 13 to 24 June (12 days) for an area cultivated with Alfalfa using the available and by using Blaney- Criddle formula:

- Average air temperature during the given period (t= 24 ^{o} C).
- Average value of crop coefficient during the specific period (K_B = 0.89).
- Monthly day light hours as a percent of day light hours of the year (P = 0.33)

$$U = 192 * K_B * P * (t + 17.8)$$
$$U = 192 * 0.89 * 0.33 * (24 + 17.8) = 2357\ m^3/fed/month$$
$$U = \frac{2357 * 100}{4200 * 30} = 1.87\ cm/day$$

Consumptive use during 12 days = 1.87 * 12 = 22.44 cm.

<u>Question (3):</u> *(c1-a2, c1-b2 and c12-b2) (18 Marks)*

1 - A crop in a sandy loam soil containing 30% stone, has an effective root depth of 0.40 m. Find the refill depth if RAW = 45 mm/m. If ε=0.70 and Θ_{FC} =0.31 find the refill point and the wilting point. If the Consumptive use is 250 m^3/fed./month and A_s = 1.4, calculate the maximum period between two watering during a certain period from the growing stage of a certain crop and the efficiency of the irrigation if the delivered water is 120m^3/fed.

RAW without stones = 0.7 * 45 = 31.5 mm/m
RAW depth = 31.5 * 0.40 = 12.6 mm
AWC depth = RAW/ε = 12.6/0.70= 18 mm
RAW %= 12.6/400 = 3.15%
RAW = Θ_{FC} - Θ_{Rp} Θ_{Rp} = 31% - 3.15% = 27.85%
AWC %= 18/400 = 4.50%
AWC = Θ_{FC} - Θ_{wp} Θ_{wp} = 31% - 4.50% = 26.50%
U= 250 m^3/fed./month

$$U = \frac{250 * 100}{4200 * 30} = 0.19 \frac{cm}{day}$$

Readily available water,

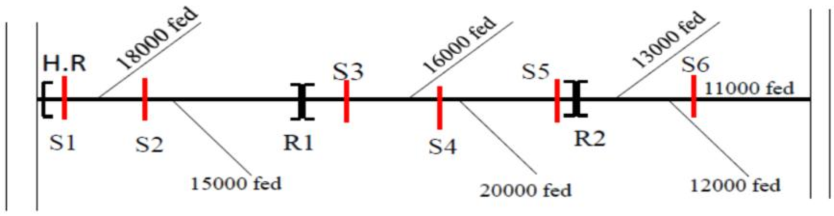
$$D = 0.01 * E_d * (\theta_{FC} - \theta_{RP}) * A_s * 0.5$$
$$D = 0.01 * 40 * (31 - 27.85) * 1.4 * 0.5 = 0.88\ cm$$

$$Frequency\ of\ Irrigation = \frac{Readily\ Available\ Water\ Content\ (cm)}{Consumptive\ Use\ \left(\frac{cm}{day}\right)}$$

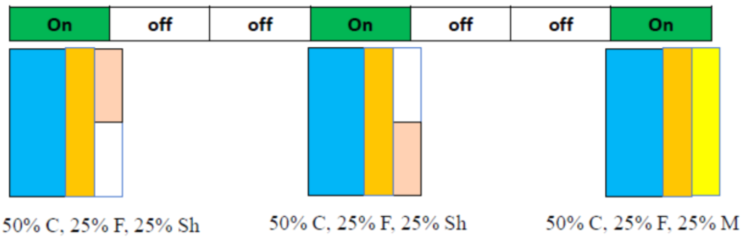
$$F = \frac{D}{U} = \frac{0.88}{0.19} = 4.6\ days = 4\ days$$

$$\tau = \frac{F * U}{Q} = \frac{4 * 250/30}{120} = 27.7\ \%$$

2 - For the shown figure, the area served by the main canal 105000 feddans, which is cultivated by 40 % Cotton (18 days,420 m^3/fed/watering), 25% Sharaki (32 days,760 m^3/fed/watering), and 25% fruits (19 days,420 m^3/fed/watering). Calculate the irrigation field duty, distributing canal, branch canal, main canal water duties Also, it is required to estimate the area served and the canal discharge at sections 1, 2, 3, 4 and 5 Considering that the compensation factor 20%.



40% Cotton, 25% Sharaki, and25 % fruits
Cotton (18 days), Fruits (19 days) and Sharaki (32 days).
Type of rotation : 3 turn rotation, No of working period = 18/3 = 6 days



$$Field\ water\ duty, F.W.D. = \sum \left(\frac{\%of\ area\ used * water\ requirement\ of\ crop}{No.of\ working\ days * No.of\ division} \right) m^3/fed/day$$

$$Field\ water\ duty, F.W.D. = \frac{40 * 420}{100 * 6 * 1} + \frac{25 * 420}{100 * 6 * 1} + \frac{25 * 760}{100 * 6 * 2} = 61.33\ m^3/fed/day$$

*Water duty for distributary canal, D.W.D= 1.1 * 61.33 = 67.47 m^3/fed/day*
*Water duty for branch canal, B.W.D = 1.2 * 61.33 = 73.6 m^3/fed/day*
*Water duty for main canal, M.W.D = 1.3 * 61.33 = 79.73 m^3/fed/day*

Sec.	A	B	C	B+αA	C+αB	A+αC	Area Served	$Q_{M.C.}$ (m^3/s)
S1	33000	36000	36000	41940	42480	39480	42480	39.20
S2	15000	36000	36000	38700	42480	21480	42480	39.20
S3	0	36000	36000	36000	42480	6480	42480	39.20
S4	0	20000	36000	20000	39600	6480	39600	36.54
S5	0	0	36000	0	36000	6480	36000	33.22
S6	0	0	11000	0	11000	1980	11000	10.15

3 - A Main canal discharges 20 m^3/s, water surface slope 10 cm/km, Side slopes 1:1, 3:2. Check the canal water velocity if the water depth is 3.0 m and canal bed width is 6.0 m, Draw and estimate the expropriation limits.

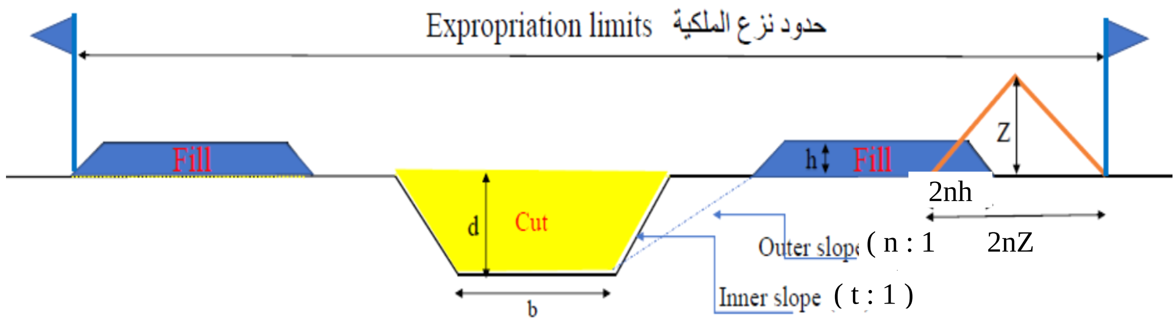
$$A = b * y + t * y^2$$

$$A = 6 * 3 + 1.0 * 3^2 = 27\ m^2$$

$$V_{act} = \frac{Q}{A_{act}} = \frac{20}{27} = 0.74\ m/s. \quad o.k.$$

Assume bank width = 6.0 m
For a branch canal freeboard = 0.50 m
Bank height, h = 1.5 m
Area of cut = 1.15(bd+td^2)=1.15(6∗3.0+1.0∗3^2) =31.05m^2
Area of fill = 2(Rh+nh^2)=2(6∗1.5+1.5∗1.5^2)=24.75m^2
If area of cut > area of fill, spoil is needed.

Required area for spoil = 31.05 – 24.75 = 6.3 m^2
Area of spoil = A_{cut} - A_{fill} = $nZ^2 \;\; nh^2$
6.3 = 1.5 * Z^2 – 1.5 * 1.5^2
Z= 2.54 m < 5.0 m (one sides of spoil is needed)
Area of right spoil = $2*5^2 \;\; 2*1.5^2 = 45.5m^2$
Expropriation limits = 6 + 2(4.5*1.5 + 6) + (2*1.5*2.54 - 2*1.5*1.5) = 28.38 m



Question (4): *(c1-a2, c1-b2 and c12-b2) (15 Marks)*

1 - Calculate the wetness percentage of a fine-textured soil irrigated by drip with 6 drippers with a drainage of 12 liters/hour around each of the trees distributed on the corners of rectangles of dimensions 6 * 5.5 meters.

*- From the table for (q = 12L/hr) and (F) soil we find that (S_{ep}) = 2.0m.

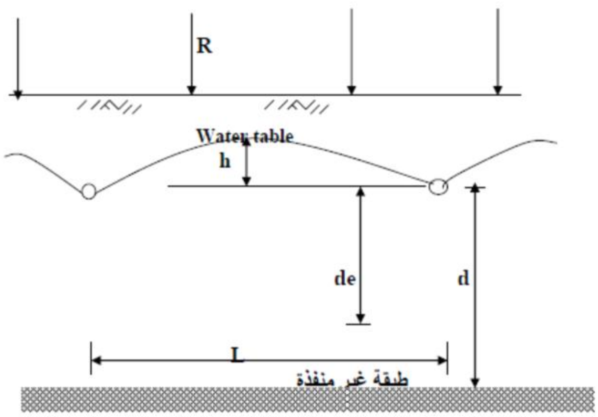
*- The average distance between the lines (S_2) which gives P_2=100% is 2.5m.

$$P = \frac{100 * n * S_{ep} * S_2}{S_r * S_t}$$

$$P = \frac{100 * 6 * 2.0 * 2.5}{5.5 * 6} = 90.91\%$$

2 - Calculate the distance between two lateral drains in covered drainage system as shown in the figure, knowing that:- Drainage Water Duty = 3 mm/day. - Minimum Depth of Drainage from Land Surface = 1.5 m. - Coefficient of Permeability = 0.16 m/day. - Depth of Pipe from Land Surface = 2.5 m. - Pipe Diameter = 25 cm. - Depth of Impermeable Layer from Land Surface = 7.5m .

d : بعد سطح الماء فى المصرف عن الطبقة الغير منفذه (شكل (7-14)).



*- R = 3mm/day = 0.003 m/day.
*- h = 2.5 -1.5 = 1.0 m.
*- r = 0.125 m.

*- k = 0.16 m/day.
*- d = 7.5 - 2.5 = 5.0 m.

$$L^2 = \frac{8 * k * h * d_e + 4 * k * h^2}{R}$$

$$L^2 = \frac{8 * 0.16 * 1 * d_e + 4 * 0.16 * 1^2}{0.003}$$

$$L = \sqrt{427 * d_e + 213} \qquad (1)$$

$$d_e = \frac{d}{1 + 6 * \left(\frac{d}{L}\right) * log\left(\frac{d}{u}\right)}$$

$$d_e = \frac{5.0}{1 + 6 * \left(\frac{5.0}{L}\right) * log\left(\frac{5.0}{0.393}\right)}$$

$$L = \frac{33.13 * d_e}{5.0 - d_e} \qquad (2)$$

*- By Trial & Error Method:

de	2.0	2.2	2.4	2.6	2.8	3.0
L (1)	32.66	33.95	35.18	36.38	37.53	38.65
L (2)	22.08	26.03	30.58	35.89	42.17	49.69
Error = L (1) - L (2)	10.58	7.92	4.60	0.48	-4.63	-11.04

*- d_e = 2.63 m.
*- L = 36.77 m.

3 – A piece of land (2250x1600) m is to be irrigated using the semi portable sprinkler system. The water demand for the proposed plants is 280 m^3/fed/turn (turn = 5 days) and the sprinkler influence circle equals 50 m. The wind is in the direction of long length. The Equivalent Sprinkler Water Depth = 9 mm/hr, Working Hours = 18 hrs and Overlay Between Circles % = 55% between sprinklers, 40% between Lines. It is required to Align the pipe system and Estimate the number of the sprinklers on each line.

$$area\ in\ acres = A = \frac{2250 * 1600}{4200} = 857\ Fed.$$

$$Water\ demand\ (mm) = 280 * \frac{1000}{4200} = 67\ mm$$

$$Spr.Wor.Hrs/mov. = \frac{67mm}{9\frac{mm}{hr}} = 7.44\ hr \approx 8hrs$$

$$Spr.Wor.Hrs/mov. = 8hrs + 1hr\ for\ moving\ the\ pipe = 9hrs$$

*- Number of Movement/Day = (Working Hours per Day / Spr. Wor. Hrs/mov.) = 18/9 = 2.
*- Number of Valves = Number of Days per Turn*Number of Movement/Day = 5 x 2 = **10 valves**.
*- Eeffective Distance Between Valves = 0.55*Diameter of Circle of Influence of The Sprinkler = 0.60*50 = 30.0 m.
*- Length of Sprinkler Pipe = 200 ms.
*- Proposed Number of Sprinkler Pipes Along the 1600 m side = 1600/200= **8**.
*- Effective Distance Between the Sprinklers = 0.4*45 = **18 ms.**
*- Number of Sprinklers Along the Sprinkler Pipe = 200/18 = 11.11≈**12 Sprinklers**
*- Proposed Branch Pipe Length = 30*2*5 =300 m.
*- Proposed Number of Branch Pipes Along the 2250 m side = 2250/300= 7.5 ≈ **8**.
*- Length of Branch Pipe = 2250/8 = 281 m.
*- Plot Dimension = 200*268.5 , Area of the Plot = (200*281)/4200 = **13.38 fed**.
*- Number of Plots = 8*8 = 64 plots.
*- Number of Sprinklers = 12*64=768 sprinklers.