B.Sc. Engg. (CEE)/ 4th Sem.

352

23 September, 2013 (Morning)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination**
**Course No. CEE 4423**
**Course Title: Hydrology**

**Summer Semester: 2012-2013**
**Full Marks: 150**
**Time: 3 hours**

**There are 8 (Eight) Questions. Answer any 6 (Six) questions. All questions carry equal marks. Programmable calculators are not allowed. Do not write on this questions paper. The symbols have their usual meaning.**

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1. a) Define a 'catchment'. What is the difference between rainfall measurement by a gage and radar? [4]

   b) Define 'Runoff Efficiency'. Why is the efficiency higher in smaller catchments? [4]

   c) The runoff data from a 2-hr storm in a 241 $km^2$ catchment is shown in the following table. If the baseflow is 50 $m^3$/sec, then derive a 2-hr and a 4-hr unit hydrograph. [17]

| Time (hrs) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Inflow ($m^3$/sec) | 50 | 50 | 170 | 300 | 250 | 200 | 150 | 100 | 50 |

2. a) What is 'return period'? What is the purpose of frequency analysis? [4]

   b) If the rank of the flood of 1960 from a record of floods from 1950-2000 period is 10, then what is the return period and probability of the flood of 1960? [4]

   c) The stage-discharge data of a river are shown in the following table. If the stage for zero discharge is 0.9 m, then determine the stage-discharge relationship and the discharge for a stage of 12 m. [17]

| Stage (m) | 1.8 | 2.0 | 2.3 | 3.7 | 4.5 | 6.1 | 7.3 | 7.7 | 8.1 |
|---|---|---|---|---|---|---|---|---|---|
| Discharge ($m^3$/sec) | 1.0 | 1.5 | 2.6 | 11.7 | 20.2 | 44.5 | 70 | 80 | 90 |

3. a) What is runoff? Classify runoff according to source. [4]

   b) What are the purposes of routing a flood hydrograph? What are the differences between 'prismatic storage' and 'wedge storage'? [4]

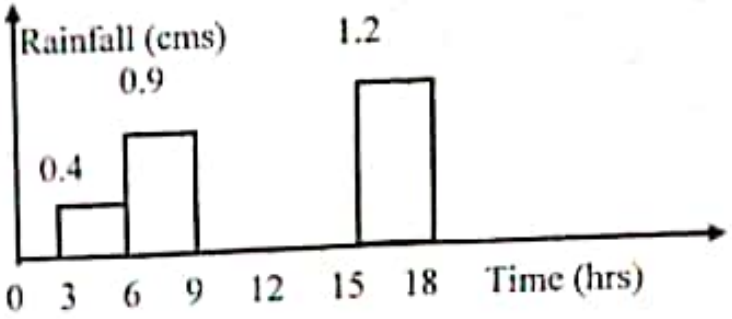
   c) What is the major limitation of the Slope-Area method of discharge measurement? [2]

   d) The runoff data from a 3-hr unit hydrograph are shown in the following table. Determine the flood hydrograph due to the following effective rainfalls. Assume a constant base flow of 300 $m^3$/sec. [15]

| Time (hrs) | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 2125 | 3325 | 2525 | 1925 | 1425 | 1025 | 650 | 350 | 125 | 0 |



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4. a) What is the difference between a tributary and a distributary? Explain how the drainage density affects the runoff. [4]
   b) What is the advantage of rainfall measurement by satellite? How is the rainfall estimated from satellite images? [4]
   c) The inflow and outflow data of a channel reach are shown in the following table. If the weighing factor (X) is 0.1, then determine the travel time (K). [17]

| Time (hrs) | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow ($m^3$/sec) | 35 | 135 | 440 | 670 | 685 | 535 | 385 | 235 | 140 | 95 | 60 |
| Outflow ($m^3$/sec) | 35 | 57 | 200 | 455 | 612 | 617 | 519 | 375 | 246 | 158 | 102 |

5. a) What is ADCP? What is the working principle of ADCP? [4]
   b) What are the limitations of the unit hydrograph theory? [3]
   c) If the base period of a 2 hr unit hydrograph is 20 hrs then what would be the base period of a 4 hr unit hydrograph? [2]
   d) The 4-hr unit hydrograph for a basin is shown in the following table. Derive a 2-hr unit hydrograph. [16]

| Time (hrs) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 200 | 400 | 600 | 500 | 400 | 300 | 200 | 100 | 0 |

6. a) Show with a figure the difference between 'lag time' and 'time to peak'? [
   b) What is precipitation? Name three different forms of precipitation. [
   c) The maximum daily rainfalls during 1976-98 period at Joydebpur are shown in the following table. If the maximum daily rainfall in 2005 was 85 mm, then what was its return period? [1
   What is the maximum daily rainfall at Joydebpur with a return period of 10 years? If a drainage system is designed for a return period of 10 years at Joydebpur then what is the risk of the design?

| Year | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 49.5 | 33.0 | 36.3 | 68.9 | 46.1 | 13.1 | 180.3 | 42.7 | 86.4 | 27.9 | 182.0 |

| Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 21.5 | 50.3 | 78.2 | 21.6 | 53.3 | 40.7 | 38.1 | 12.8 | 17.0 | 34.3 | 47.8 | 91.4 |



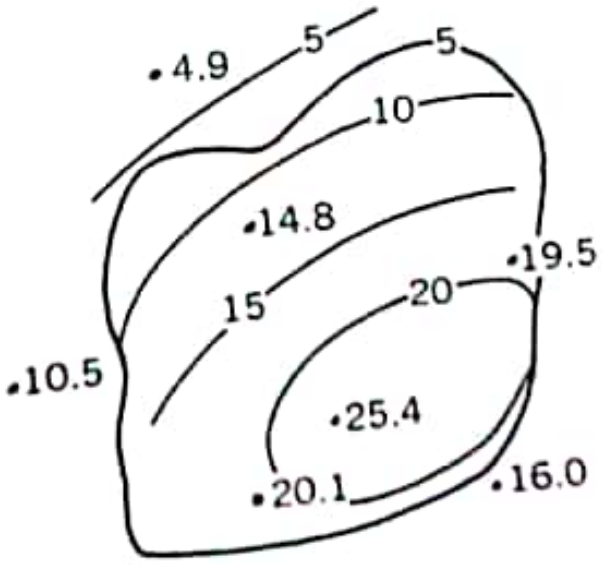
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7. a) What is pan coefficient? Why is it necessary? [4]
   b) What is the difference between intermittent stream and ephemeral stream? [3]
   c) Why is the infiltration rate less in bare soil compared to vegetated soil? [3]
   d) The infiltration rates observed during a double ring infiltrometer test are shown in the following table. Derive the Horton's equation. [15]

| Time (hr) | 0.017 | 0.058 | 0.125 | 0.25 | 0.50 | 0.75 | 1.25 | 2.5 |
|---|---|---|---|---|---|---|---|---|
| Infiltration Rate (cm/hr) | 8.76 | 7.90 | 6.45 | 4.68 | 2.75 | 1.76 | 1.10 | 1.1 |

8. a) What is a rating curve? Explain with a figure the 'loop rating curve'. [4]
   b) Compute the probability that two10-year floods will occur in 10-year design period of a project. [5]
   c) Draw the velocity profile in a river and show the depths of maximum and mean velocities. [3]
   d) The isohyets for a 6 hour rainfall in a watershed are shown in the figure. If the areas within isohyets are as shown in the table then draw the 6 hour DAD curve. [13]

| Isohyet (mm) | 5 - 10 | 10-15 | 15-20 | >20 |
|---|---|---|---|---|
| Area ($km^2$) | 7.2 | 12.8 | 15.4 | 9.6 |




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# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** — **Summer Semester: 2011-2012**
**Course No. CEE 4423** — **Full Marks: 150**
**Course Title: Hydrology** — **Time: 3 hours**

**There are 8 (Eight) questions. Answer any 6 (Six) questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning.**

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1. a) What do you mean by a 2-hr unit hydrograph and a 2-hr hydrograph? What is the rainfall intensity for a 0.5 hr unit hydrograph? [4]
   b) The outflows of a 2-hr rainfall from a 20 $km^2$ catchment are shown in the following table. Considering a constant base flow of 75 $m^3$/sec, derive a 2-hr unit hydrograph.

| Time (hrs) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 75 | 110 | 205 | 305 | 280 | 205 | 130 | 75 |

   If three successive 2-hr rainfall generate effective rainfall of 1.1, 2.1 and 1.8 cm in the above catchment, then derive the resulting hydrograph. [21]

2. a) Show in a hydrograph the base flow, crest, falling limb and recession limb. [4]
   b) What basin characteristics affect the amount of runoff? [3]
   c) For a 400 $km^2$ basin with basin length (L) of 45 km and length from centroid (Lc) of 25 km derive a 2-hr unit hydrograph and show the parameters in the hydrograph. Assume basin characteristics of $C_t = 1.257$ and $C_p = 0.576$. [18]

3. a) What is time of concentration? How does it affect the peak flow for a given rainfall duration? [4]
   b) How does shape and land use of a watershed affect the peak runoff? [4]
   c) The direct runoff hydrograph from three successive 1-hr rainfall of 1.06, 1.93 and 1.81 cm are shown in the following table. Determine the 1-hr unit hydrograph. [17]

| Time (hr) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 428 | 1923 | 5297 | 9131 | 10625 | 7834 | 3921 | 1846 | 1402 | 830 | 313 |

4. a) What is the difference between interflow and base flow? [3]
   b) What are the similarities and differences between a 2-hr unit hydrograph and a 6-hr unit hydrograph for a basin? Which hydrograph would have a higher peak flow and why? [5]
   c) If a flood of 5 meter or greater occurs on average once in every 10 years then what is the probability it will not occur for the next 8 years? [7]
   d) If a road is designed for a 50 year flood then what is the probability that the 50 year flood will occur once in 10 years? What are the risk and reliability of the design? [10]

5. a) If the peak flow and base period of a 4-hr unit hydrograph are 30 $m^3$/sec and 20 hrs then what would be the peak flow and base period from a 4-hr rainfall generating 2 cm of runoff? [4]



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b) Why is the unit hydrograph concept not valid for large basins? [4]

c) The flows during the recession period of a hydrograph are shown in the following table. Determine the recession equation. [17]

| Time (days) | 16 | 18 | 20 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 250 | 151 | 100 | 70 | 58 | 49 | 41 |

6. a) For the generation of synthetic unit hydrograph why it is important that the basin be located near a gaged basin? [3]
   b) What are the advantages of remotely sensed data in hydrology? [4]
   c) The 24-hr rainfall at Gazipur for 1980-2001 period are shown in the following table. Develop a 24-hr IDF curve for Gazipur. [18]

| Year | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 27 | 35 | 29 | 16 | 24 | 56 | 30 | 16 | 62 | 23 | 46 |

| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 21 | 26 | 18 | 27 | 22 | 19 | 54 | 30 | 38 | 33 | 31 |

7. a) What is routing? Explain with a figure 'attenuation' and 'time lag'. [5]
   b) Yearly rainfall data of Joydebpur are available from 1962-2010. If the rank of the rainfall in 2001 is 10 then what is the probability of that rainfall? What is the return period? [5]
   c) Determine the discharge of Tongi Khal from the following data. [15]

| Distance from left bank (m) | Depth (d) of water (m) | Velocity (m/sec) | | |
|---|---|---|---|---|
| | | At 0.6d | At 0.2d | At 0.8d |
| 0 | 0 | | | |
| 3 | 1.4 | 0.122 | | |
| 6 | 3.3 | | 0.269 | 0.176 |
| 9 | 5.0 | | 0.257 | 0.218 |
| 12 | 9.0 | | 0.290 | 0.227 |
| 15 | 5.4 | | 0.245 | 0.230 |
| 18 | 3.8 | | 0.251 | 0.218 |
| 21 | 1.8 | 0.158 | | |
| 24 | 0 | | | |

8. a) The outflow versus storage (O and $2S/\Delta t + O$) data of a reservoir are shown in the following table.

| Outflow ($m^3$/sec) | 0 | 5 | 10 | 15 | 20 |
|---|---|---|---|---|---|
| $(2S/\Delta t + O)$ $m^3$/sec | 0 | 55 | 130 | 200 | 400 |

Calculate the peak outflow from the reservoir for the following inflows: [18]

| Time (hrs) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Inflow ($m^3$/sec) | 0 | 20 | 40 | 60 | 50 | 30 | 0 |





b) The following rainfall data were taken from 5 stations. What is the missing rainfall at station X? [7]

| Station | Annual rainfall (cm) | Storm Event (cm) |
|---|---|---|
| A | 42 | 2.6 |
| B | 41 | 3.1 |
| C | 39 | 2.3 |
| X | 41 | ? |

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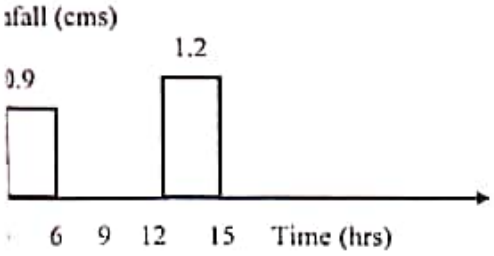
# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## THE ORGANISATION OF THE ISLAMIC CONFERENCE (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination** — **Summer Semester: 2010-2011**
**Course No. CEE 4423** — **Full Marks: 150**
**Course Title: Hydrology** — **Time: 3 hours**

**re are 8 (Eight) Questions. Answer any 6 (Six) questions. All questions carry equal marks. Programmab lators are not allowed. Do not write on this questions paper. The symbols have their usual meaning.**

(a) Show in a hydrograph the difference between base flow and direct runoff. (3)
(b) What is depression storage? What eventually happens to water in depression storage? (4)
(c) What is drainage density? How does drainage density affect the shape of the hydrograph? (4)
(d) The flow data from a 3-hr unit hydrograph are shown in the following table. Determine the flood hydrograph due to the following effective rainfalls as shown below. Assume a constant base flow of 300 $m^3$/sec.(14)

| Time (hrs) | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 2125 | 3325 | 2525 | 1925 | 1425 | 1025 | 650 | 350 | 125 | 0 |




a) Explain how shape and slope of a catchment affect the runoff. (4)
b) What is Φ index? What happens when the Φ index is greater than the rainfall intensity? (5)
c) The runoff data for a 6 hour storm with 15 cm of rainfall from 104 $km^2$ catchment are shown in the following table. Develop a 6 hour unit hydrograph for the catchment and also calculate the Φ index. (1

| | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ff sec) | 14 | 159 | 260 | 286 | 221 | 187 | 157 | 133 | 113 | 93 | 76 | 65 | 55 | 47 | 40 | 34 | 18 | 14 |

a) What is base period of a hydrograph? If the base period of a 2 hr unit hydrograph is 48 hrs, what woul be the base period of a 4 hr unit hydrograph? (4)
b) What is time of concentration? Explain how time of concentration affects the peak flow generation fro a watershed. (5)

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The direct runoff from three successive 4 hr storms producing 8 cm, 3 cm and 16 cm of effective rainfall are shown in the following table. Derive a 4 hr unit hydrograph. (16)

| Time (hrs) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow($m^3$/sec) | 0 | 160 | 300 | 570 | 636 | 404 | 234 | 105 | 48 | 0 |

(a) What are the intensity, duration and amount of effective rainfall of a 6 hr unit hydrograph? (3)
(b) Show with figures the difference between DAD and IDF curves. (5)
(c) What is return period? What are the purposes of frequency analysis? (4)
(d) The ordinates of a 4 hr unit hydrograph are shown in the following table. Derive a 6-hr unit hydrograph. (13)

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The direct runoff from three successive 4 hr storms producing 8 cm, 3 cm and 16 cm of effective rainfall are shown in the following table. Derive a 4 hr unit hydrograph. (16)

| Time (hrs) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow($m^3$/sec) | 0 | 160 | 300 | 570 | 636 | 404 | 234 | 105 | 48 | 0 |

1 (a) What are the intensity, duration and amount of effective rainfall of a 6 hr unit hydrograph? (3)
(b) Show with figures the difference between DAD and IDF curves. (5)
(c) What is return period? What are the purposes of frequency analysis? (4)
(d) The ordinates of a 4 hr unit hydrograph are shown in the following table. Derive a 6-hr unit hydrograph. (13)

| Time (hrs) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 25 | 100 | 160 | 190 | 170 | 110 | 70 | 30 | 20 | 6 | 1 | 0 |

5 (a) What are the limitations of unit hydrograph theory? (4)
(b) Explain with a figure how the antecedent soil moisture content affects the infiltration rate. (4)
(c) Determine the peak discharge from 10 year 1 day rainfall for IUT campus (5 hectares of buildings and hectares of open area with runoff coefficients of 0.7 and 0.15 respectively). The maximum flow length m with an average slope of 2%. The maximum 1-day rainfall data for Joydebpur are shown in the follo table. (17)

| Year | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 49.5 | 33.0 | 36.3 | 68.9 | 46.1 | 13.1 | 180.3 | 42.7 | 86.4 | 27.9 | 182.0 |

| Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 21.5 | 50.3 | 78.2 | 21.6 | 53.3 | 40.7 | 38.1 | 12.8 | 17.0 | 34.3 | 47.8 | 91.4 |

6 (a) A drainage structure is designed for a return period of 50 years. What is the risk in the design? What is the reliability of the design? (5)
(b) The outflow versus storage (O and $2S/\Delta t + O$) data of a reservoir are shown in the following table.

| Outflow ($m^3$/sec) | 0 | 18 | 37 | 50 | 70 |
|---|---|---|---|---|---|
| ($2S/\Delta t + O$) $m^3$/sec | 0 | 69 | 200 | 245 | 300 |

Calculate the outflows from the reservoir for the following inflows: (20)

| Time (hrs) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Inflow ($m^3$/sec) | 0 | 20 | 40 | 60 | 50 | 30 | 0 |

7 (a) What is the probability that a 50 year flood will not occur in 50 years? What is the probability that it will occur once? (5)
(b) What is the difference between direct runoff hydrograph and unit hydrograph? (4)
(c) The inflow hydrograph through a channel section is given in the following table. Determine the outflo from the section if K and X are 2 hr and 0.2, respectively. Assume the initial outflow as 0 and $\Delta t$ as 1 hr. (16)

| Time (hrs) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Inflow ($m^3$/sec) | 0 | 10 | 20 | 30 | 20 | 10 | 0 |

8 (a) What are the advantages of 'Moving boat method' over 'Area velocity method' of discharge measurement? (4)
(b) Explain the terms: perennial stream, tributary and distributary. (3)
(c) The following stages and discharges were measured for Sonali river at Ruppur. If the stage at zero discharge is 0.9 m, then develop the stage-discharge relationship for Sonali river and determine the discharge at a stage of 12 m. (18)

| Stage (m) | 1.8 | 2.0 | 2.3 | 2.9 | 3.7 | 4.5 | 5.4 | 6.1 | 7.3 | 7.7 | 8.1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Discharge ($m^3$/sec) | 1.0 | 1.5 | 2.6 | 5.6 | 11.7 | 20.2 | 32.5 | 44.5 | 70.0 | 80.0 | 90.0 |

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B.Sc. Engg. (CEE)/4th Sem. 401

26 October, 2015

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
## DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Semester Final Examination**
**Course No.: CEE 4423**
**Course Title: Hydrology**

**Summer Semester: 2014-2015**
**Full Marks: 150**
**Time: 3 Hours**

**There are 8 (Eight) questions. Answer any 6 (Six) questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning.**

1. (a) What is the relationship between saturated vapour pressure and temperature? How is evaporation related to vapour pressure? (5)

(b) What is return period? What are risk and reliability? (4)

(c) A 5 hour storm in a 35 $km^2$ watershed had hourly intensities of 20, 16, 14, 12 and 5 mm/hr. If the $\Phi$ index for the catchment is 5 mm/hr, then what is the depth of direct runoff? (8)

(d) The initial and the constant infiltration rates for a 25 $km^2$ catchment are 16 and 6 mm/hr and the Horton's constant is 2 $hr^{-1}$. If a storm with an intensity of 22 mm/hr occurs in the catchment for 45 minutes, then what is the volume of infiltration? (8)

2. (a) Explain with a figure what is effective rainfall? How is effective rainfall affected by the land use of a watershed? (5)

(b) What is drainage density? How does drainage density affect the runoff from a watershed? (4)

(c) Explain the difference between frontal rainfall and orographic rainfall. (3)

(d) The following survey data were measured for a canal. Compute the canal discharge. (13)

| Distance from left bank (m) | Depth (d) of water (m) | Velocity (m/sec) | | |
|---|---|---|---|---|
| | | At 0.6d | At 0.2d | At 0.8d |
| 0.8 | 0.5 | 0.125 | | |
| 1.6 | 1.0 | | 0.183 | 0.262 |
| 2.4 | 1.6 | | 0.200 | 0.255 |
| 3.0 | 2.0 | | 0.221 | 0.268 |
| 3.6 | 2.0 | | 0.216 | 0.270 |
| 4.2 | 1.8 | | 0.208 | 0.267 |
| 5.0 | 1.2 | | 0.194 | 0.260 |
| 5.8 | 0 | | | |

3. (a) Explain the difference between ephemeral and effluent stream. (3)

(b) Explain with examples the difference between a tributary and a distributary. (3)



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(c) Show with figures the difference between 'rating curve' and 'mass curve'. (4)

(d) What is a '3-hour unit hydrograph'? Between a 3-hour and a 5-hour unit hydrograph, which hydrograph would have a higher peak discharge and why? (3)

(e) The direct runoff data from three successive 1-hr storms of 1.06 cm, 1.93 cm and 1.81 cm in a basin are shown in the following table. Derive a 1-hr unit hydrograph. (12)

| Time (hr) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 43 | 192 | 530 | 913 | 1063 | 783 | 392 | 185 | 140 | 83 | 31 |

4. (a) Draw the velocity profile in a river and show the locations of maximum, minimum and average velocities. (3)

(b) What is the difference between 'area-velocity' and 'area-slope' method of discharge measurement? Which is more accurate and why? (5)

(c) What are 'time of concentration' and 'time to peak'? Explain how the time of concentration affects the peak flow of a watershed. (5)

(d) The outflows from a 6-hour storm in a 771.1 $km^2$ catchment are shown in the following table. If the base flow is 25 $m^3$/sec, then derive a 6-hour unit hydrograph. What is the $\Phi$ index? (12)

| Time (hr) | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 50 | 200 | 345 | 385 | 335 | 255 | 185 | 130 | 85 | 55 | 35 | 0 |

5. (a) Explain with a figure what is a 'loop rating curve'? (3)

(b) What is the difference between interception storage and depression storage? What is the difference between direct runoff and surface runoff? (4)

(c) What are the assumptions in the derivation of unit hydrograph? What are the major limitations? (5)

(d) The maximum 24-hour rainfall at Rupnagar is shown in the following table. Develop a 24-hour IDF curve. (13)

| Year | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 71.1 | 61.9 | 57.5 | 135.6 | 89.1 | 68.5 | 77.2 | 75.2 | 122.4 | 104.2 |

| Year | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 67.5 | 448.7 | 78.1 | 81.6 | 147 | 83.1 | 70.5 | 50.8 | 72.4 | 90.4 |

6. (a) Explain with a figure the difference between base flow and base period of a hydrograph. (4)

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(b) If the peak flow and the base period of a 5-hr unit hydrograph in a 45 $km^2$ watershed are 36 $m^3$/sec and 30 hours, then what would be the peak flow and base period from 5-hr storm with 4 cm effective rainfall in the same watershed. (3)

(c) What is the difference between 'rain' and 'sleet'? (3)

(d) The ordinates of a 4-hr unit hydrograph for catchment are shown in the following table. Derive a 2-hour unit hydrograph. What is the area of the catchment? (15)

| Time (hr) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 25 | 100 | 160 | 190 | 170 | 110 | 70 | 30 | 10 | 5 | 0 |

7.(a) What is frequency analysis? If the rank of a flood is 5 in a set of 40 years of data, then what is the probability of exceedence of that flood in a year. (4)

(b) If a flood of 5 m or greater occurs on average once every 10 years, what is the probability that it will not occur for the next 5 years? What is the probability that it will occur at least once in 10 years? (6)

(c) What is remote sensing? What are the advantages of remotely sensed data? (4)

(d) In a 3000 $km^2$ catchment the total length of the main stream is 120 km and the distance from the centroid of the catchment to the outlet is 63 km. If the peak flow factor and the lag factor are 0.64 and 1.60, respectively, then derive a 3-hour unit hydrograph and determine the peak discharge. Show the calculated hydrograph parameter in a figure. (11)

8.(a) What is flood routing? Explain with a figure the effect of routing on flood hydrograph. (4)

(b) If the flow at the start of a recession curve is 245 $m^3$/sec and the recession constant is 0.78, then what is the flow 4 hours after the start of the recession? (4)

(c) What is a lysimeter? Why is 'double ring' preferred over 'single ring' infiltrometers in measurement of infiltration? (4)

(c) The amounts of rainfall (in mm) due to a 6-hr storm in stations A (5.5), B (9), C (23.3), D (55) and E (14) of a watershed are shown in Figure 1. Determine the 6-hr DAD curve for the watershed. Attach Figure 1 with your answer script. (13)

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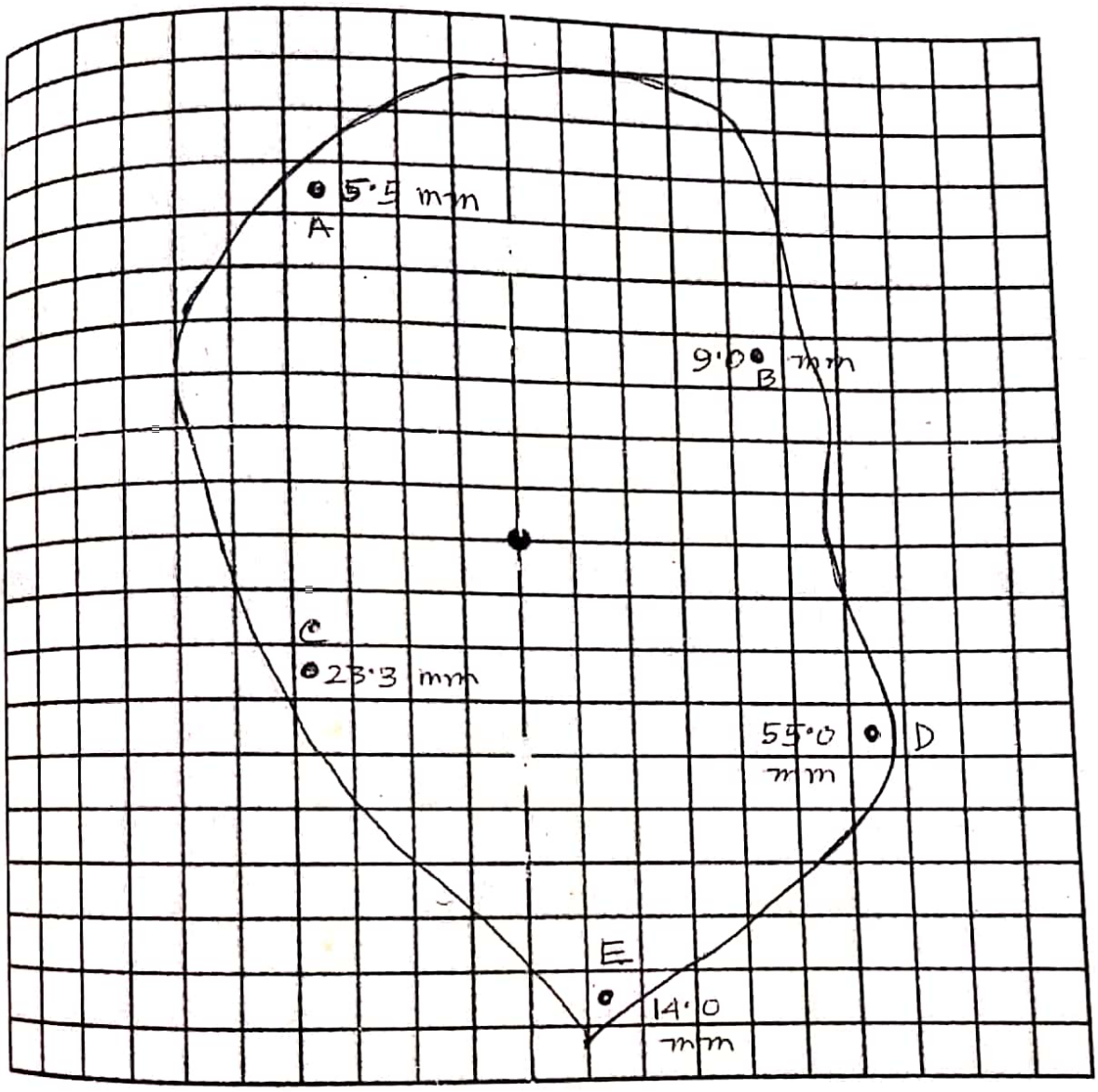



Figure 1
(One small square is one square km)

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19 October 2014 (Morning)

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**
THE ORGANIZATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

AM : FINAL EXAMINATION SUMMER SEMESTER : 2013-2014
URSE NO. : CEE 4423 TIME : 3 Hours
URSE TITLE : Hydrology FULL MARKS : 150

There are 8 (Eight) Questions. Answer question no. 1 and any other 5 (five) questions. All questions ry equal marks. Programmable calculators are not allowed. Do not write on this questions paper. The symbols have their usual meaning.

Write T for true and F for false statement. Equal negative mark for wrong answer. [25]

a. Out of the world's total water only about 10% is fresh.
b. The quality of water changes during the passage of one form to another of the hydrologic cycle.
c. The watershed boundary does not generally coincide with the territorial boundary.
d. As the temperature increases the saturated moisture content of the atmosphere decreases.
e. The rain gauge network of Bangladesh can be considered as adequate.
f. For a given storm, the depth of rainfall decreases with the increase of catchment area.
g. In a catchment, the intensity of rainfall increases with the increase in storm duration.
h. In a global scale, evaporation and precipitation are about the same.
i. Out of the total evaporated water in the atmosphere only about 10% comes from transpiration.
j. In Bangladesh there is regional variation of rainfall but not of evaporation.
k. Both Φ index and W index are average rates of infiltration for a watershed.
l. The velocity distribution in a stream is non-uniform both along the flow and across the flow.
m. Propeller type current meters give better measurement of velocity than the cup type current meters.
n. The smallest reading of rainfall is in mm and that of water level is in cm.
o. Interflow is a portion of the infiltrated water that moves laterally to the streams.
p. A catchment with a low drainage density will have high runoff.
q. If two $2^{nd}$ order streams are joined then the resulting stream is a $3^{rd}$ order stream.
r. In a catchment, the time to peak is always less than the time of concentration.
s. The runoff coefficient is higher for a developed area than an undeveloped area.
t. The rainfall intensities are same in 3-hr and 6-hr unit hydrograph.
u. If the time base of a 2-hr unit hydrograph is 40 hours, then time base of 4-hr unit hydrograph is 42 hours.
v. If the risk of designed structure is 20% then there is 20% probability that the structure would not fail within the design life.
w. The rainfall intensity increases with the increase of

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2 (a) What is effective rainfall? If the effective rainfall from a 3-hr storm in a 20 $km^2$ catchment is 5 cm, then what would be total volume of direct runoff? [05]

(b) The outflows from a 104 $km^2$ drainage for a 4-hr storm are shown in the following table. Assuming a constant base flow of 15 $m^3$/sec, derive the 4-hr unit hydrograph. If a 4-hr storm produces 3 cm of effective rainfall then what would be the peak discharge? What is the peak flow of a 8-hr unit hydrograph? [20]

| Time (hr) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 15 | 173 | 274 | 298 | 235 | 198 | 170 | 143 | 124 | 104 | 86 | 15 |

3 (a) What is the difference between interception storage and depression storage? What ultimately happen to these storages? [04

(b) Estimate the volume of infiltration from a 3-hr storm producing 5 cm of rainfall if the $\Phi$ index is 0.45 cm/hr. [03

(c) If the base period of a 4-hr unit hydrograph is 18 hours then what would be the base period of 4-hr unit hydrograph with an effective rainfall of 3 cm. [02

(d) The following stage-discharge data are available for Chalti river. If the stage at zero discharge is 1.6 m, then derive the stage-discharge relationship for Chalti river. [16

| Stage (m) | 4.4 | 5.3 | 6.1 | 6.5 | 7.2 | 7.5 | 7.7 | 8.1 | 8.5 |
|---|---|---|---|---|---|---|---|---|---|
| Discharge ($m^3$/sec) | 320 | 456 | 583 | 651 | 821 | 906 | 985 | 1098 | 1296 |

4 (a) What are the three components of runoff? Which is highest in magnitude and which is lowest? [0

(b) What are the two basic parameters of synthetic unit hydrograph? How can these two parameters be estimated? [0

(c) How do altitude and relative humidity affect the rate of evaporation? [0

(d) The following data are for a 4-hr unit hydrograph. Derive a 6-hr unit hydrograph. [1

| Time (hr) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 25 | 100 | 160 | 190 | 170 | 110 | 70 | 30 | 20 | 10 | 0 |

5 (a) What is time of concentration? Explain how time of concentration and duration of rainfall affect the peak flow. [0

(b) What is return period? What is risk? [0

(c) The following data were obtained from a double ring Infiltrometer test. Determine the Horton's equation. [1

| Time from start of experiment (min) | 3 | 15 | 30 | 60 | 90 | 120 | 150 |
|---|---|---|---|---|---|---|---|
| Infiltration rate (cm/hr) | 4.41 | 3.92 | 3.21 | 2.55 | 2.32 | 2.21 | 2.11 |

6 (a) What is the probability that a 20 year flood will occur twice in 10 years? What is the probability that it will occur at least once in 10 years? [0

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(b) What are the differences between a 2-hr hydrograph and a 2-hr unit hydrograph? [03]
(c) The maximum 1-day rainfall data for Joydebpur are shown in the following table. [16] Develop the IDF curve for 1-day rainfall at Joydebpur.

| Year | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 83 | 56 | 18 | 31 | 283 | 152 | 26 | 32 | 29 | 42 | 65 | 69 |

| Year | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 36 | 48 | 41 | 29 | 79 | 42 | 19 | 15 | 57 | 55 | 30 | 58 |

7 (a) What is the difference between precipitation and rainfall? What is artificial rainfall? [04]
(b) What is the difference between infiltration rate and infiltration capacity? Explain with figure how the infiltration capacity curve would change if the rainfall intensity is less than the infiltration capacity at the beginning of the rainfall. [05]
(c) The following table shows the inflows to a river reach with K = 2 days and X = 0.2. [16] If the initial outflow is the same as the inflow, then calculate the peak outflow.

| Time (day) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 120 | 180 | 260 | 414 | 480 | 560 | 604 | 580 | 460 | 404 | 320 | 290 |

8 (a) Draw the velocity profile of a river and explain the points where the velocity is highest and lowest. How is the mean velocity estimated? [05]
(b) Why is a correction factor applied in the velocity measured by float method? What is the value of the coefficient? [03]
(c) The direct runoff data from three successive 4-hr storms of 8 cm, 3 cm and 16 cm in a basin are shown in the following table. Derive a 4-hr unit hydrograph. [17]

| Time (hr) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow ($m^3$/sec) | 0 | 160 | 300 | 570 | 636 | 404 | 234 | 105 | 48 | 0 |

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B.Sc. Engg. (CEE)/4th Sem.

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**
ORGANISATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**12 August, 2016. (Morning)**

TERM : MID SEMESTER EXAMINATION
COURSE NO.: CEE 4423
COURSE TITLE: HYDROLOGY

SUMMER SEMESTER: 2015-16
TIME: 1.5 Hours
FULL MARKS:75

**There are 4 (Four) questions. Answer any 3 (Three) questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning.**

1 (a) What is hydrologic cycle? What are the important phases of hydrologic cycle? (3)

(b) Draw a rainfall mass curve and explain how rainfall intensity can be obtained from the mass curve. (5)

(c) The annual rainfall of a watershed with 5 gauges is shown in the following table. Calculate the optimum number of gauges for the watershed for a 10% error in estimation. (7)

| Station | A | B | C | D | E |
|---|---|---|---|---|---|
| Rainfall(mm) | 92.6 | 112.9 | 190.3 | 120.3 | 108.8 |

(d) Explain the working principle of radars in rainfall measurement. (3)

(e) What is the difference between rain and drizzle? Explain the role of 'nuclei' in the formation of precipitation (3)

(f) What are the advantages and disadvantages of "Thiessen Polygon Method" and "Isohytal Method"? Which method you think is more accurate and why? (4)

3 (a) Explain with a figure the relationship between rainfall intensity and infiltration rate. (3)

(b) Why a pan coefficient is used in evaporation measurement? What is the pan coefficient for US Class A weather pan? (3)

(c) The measured infiltration rates from a double ring infiltrometer are as shown in the following table. Determine the best values of the parameters in Horton's infiltration capacity equation to represent this data set. (13)

| Time from the beginning (min) | 2 | 7 | 15 | 30 | 60 | 90 | 150 | 200 | 300 |
|---|---|---|---|---|---|---|---|---|---|
| Infiltration rate(cm/hr) | 26.4 | 23.7 | 19.5 | 14.1 | 8.4 | 5.4 | 3.3 | 3.0 | 3.0 |



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(d) Hourly rainfalls of 2.5, 6, and 3 cm occur over a 20-ha area consisting 4 ha of $\varphi$ =5 cm/hr, 10 ha of $\varphi$ = 3 cm/hr, and 6 ha of $\varphi$ = 1 cm/hr. Derive hourly values of net rain. (6)

3. (a) The annual rainfalls at Station "X" and the average of three surrounding stations are shown in the following table. Check the consistency of data and make corrections if necessary. (13)

| Year | Annual rainfall of "X" (mm) | Average annual rainfall of three stations(mm) |
|---|---|---|
| 2000 | 497.2 | 429.0 |
| 1999 | 547.8 | 486.2 |
| 1998 | 764.5 | 740.3 |
| 1997 | 720.5 | 546.7 |
| 1996 | 1653.3 | 1646.7 |
| 1995 | 268.4 | 322.3 |
| 1994 | 996.6 | 889.9 |
| 1993 | 491.7 | 715.0 |
| 1992 | 388.3 | 537.9 |
| 1991 | 551.1 | 844.8 |
| 1990 | 334.4 | 553.3 |

(b) What is the difference between infiltration and percolation? (3)

(c) Explain with a figure the difference between convective and orographic rainfall. (6)

(d) How does the vapor pressure of the atmosphere affect the evaporation? (3)

4 (a) What are the factors that control transpiration? (6)

(b) How does vegetation cover affect the infiltration? (3)

(c) Explain with a figure why the velocity in a river is measured at 60% of depth. (3)

(d) Determine the discharge of Turag river from the following data (13)

| Distance from left bank(m) | Depth (d) of water (m) | Velocity(m/s) | | |
|---|---|---|---|---|
| | | At 0.6d | At 0.2d | At 0.8d |
| 0 | 0 | | | |
| 3 | 1.54 | 0.111 | | |
| 6 | 3.63 | | 0.245 | 0.160 |
| 9 | 5.50 | | 0.234 | 0.198 |
| 12 | 9.90 | | 0.264 | 0.206 |
| 15 | 5.94 | | 0.223 | 0.209 |
| 18 | 4.18 | | 0.228 | 0.198 |
| 21 | 1.98 | 0.144 | | |
| 24 | 0 | | | |

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