



UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019**

COURSE NAME : HYDROLOGY
COURSE CODE : BFC32002
PROGRAMME CODE : BFF
EXAMINATION DATE : DECEMBER 2018/ JANUARY 2019
DURATION : 2 HOURS 30 MINUTES
INSTRUCTION : ANSWER:
1) ALL QUESTIONS IN **PART A.**
2) ANY **THREE (3)** QUESTIONS
FROM **PART B.**

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THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

PART A

- Q1** (a) 'The fundamental law of groundwater movement is that it flows through porous media'. Describe this statement by illustrating Darcy's experimental concept on a vertical pipe filled with sand conditions. (4 marks)
- (b) Explain **FIVE (5)** negative effects of over-pumping aquifers. (5 marks)
- (c) The soil under a dam consists of four layers as tabulated in **TABLE Q1 (c)**. Analyze;
- (i) Average vertical conductivity of the soil. (3 marks)
- (ii) Transmissivity of the soil. (3 marks)
- (d) An extraction well was drilled penetrating straight into the unconfined aquifer with the thickness of 40 m and the constant pumping rate is 0.08 m³/s. The groundwater drawdown for the first extraction well with a distance of 20 m is 4.5 m whereas the drawdown for the second extraction well with a distance of 190 m is 1.5 m. Analyze;
- (i) Sketch and label accordingly each value the cross section of unconfined aquifer system. (3 marks)
- (ii) Calculate Hydraulic conductivity of the groundwater through the soil media when it was being pumped out. (4 marks)
- (iii) Classify the type of this layer based on **TABLE Q1 (d)**. (3 marks)

PART B

- Q2** (a) Define the terms catchment area and hydrological data. (4 marks)
- (b) Differentiate between convective precipitation and cyclonic precipitation. (5 marks)
- (c) The normal annual precipitation of six rain-gauge stations namely A, B, C, D, E and F are respectively 130, 145, 112, 125, 134 and 150 cm. During a particular storm the precipitation recorded by station A, B, C, D and E are 15, 10, 7, 13 and 12, respectively. Calculate the rainfall at station F during that storm. (8 marks)
- (d) **FIGURE Q2 (d)** shows four rain-gauges with rainfall amounts in a catchment area. By using Thiessen polygon method, plot the sketch of polygon and determine average rainfall amount for the catchment area. (8 marks)
- Note: Please attach **FIGURE Q2 (d)** in your answer booklet.

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- Q3**
- (a) Identify **FOUR (4)** types of evaporimeter pans that are commonly used for evaporation estimation. (4 marks)
 - (b) Discuss your understanding on Infiltration Indexes. (5 marks)
 - (c) The rainfall rate and infiltration rate of a watershed are 150 mm/hr and 80 mm/hr, respectively. If soil of watershed has fair pasture cover,
 - (i) Estimate surface runoff in mm/hr. (3 marks)
 - (ii) Illustrate the relationship with the aid of sketches between rainfall, infiltration and surface runoff during storm event. (5 marks)
 - (d) The infiltration rate for a small catchment area is 4.5 cm/hr initially and it decreases exponentially toward a constant rate of 0.5 cm/hr. A total of 30 cm of water infiltrated during an 8 hour interval. Determine the k value of the Horton's equation. (8 marks)
- Q4**
- (a) Define the Intensity-Duration-Frequency (IDF) curve and surface run-off. (4 marks)
 - (b) Explain the application of Bubble Gauge recorder.
 - (c)
 - (i) By using ultrasonic method, determine the velocity of a river having the following parameters
 $L = 6 \text{ km}$, $t_1 = 20 \text{ s}$, $t_2 = 27 \text{ s}$ and $\theta = 35^\circ$ (3 marks)
 - (ii) A 230 g/L of tracer solution was discharged at the upstream of river with a constant rate of 28 L/s. At a sufficiently distance downstream section, the tracer concentration was found to reach an equilibrium value of 45 ppm. Estimate discharge in the stream if initial concentration of tracer solution in the stream are zero and 6 ppm (part per million). (5 marks)
 - (d) **TABLE Q4 (d)** was obtained from the current meter gauging ($v = 0.21N_s + 0.03$) of a stream. Estimate the stream discharge by using the mid-section method. (8 marks)

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841. 842. 843. 844. 845. 846. 847. 848. 849. 850. 851. 852. 853. 854. 855. 856. 857. 858. 859. 860. 861. 862. 863. 864. 865. 866. 867. 868. 869. 870. 871. 872. 873. 874. 875. 876. 877. 878. 879. 880. 881. 882. 883. 884. 885. 886. 887. 888. 889. 890. 891. 892. 893. 894. 895. 896. 897. 898. 899. 900. 901. 902. 903. 904. 905. 906. 907. 908. 909. 910. 911. 912. 913. 914. 915. 916. 917. 918. 919. 920. 921. 922. 923. 924. 925. 926. 927. 928. 929. 930. 931. 932. 933. 934. 935. 936. 937. 938. 939. 940. 941. 942. 943. 944. 945. 946. 947. 948. 949. 950. 951. 952. 953. 954. 955. 956. 957. 958. 959. 960. 961. 962. 963. 964. 965. 966. 967. 968. 969. 970. 971. 972. 973. 974. 975. 976. 977. 978. 979. 980. 981. 982. 983. 984. 985. 986. 987. 988. 989. 990. 991. 992. 993. 994. 995. 996. 997. 998. 999. 1000.



- Q5** (a) Define the terms natural hydrograph and unit hydrograph. (4 marks)
- (b) Explain the steps in producing a unit hydrograph. (5 marks)
- (c) **TABLE Q5 (c)** shows data for two (2) natural hydrographs from two (2) different storms for catchment area of 15 km². Derive the average unit hydrograph in m³/s per cm runoff. (8 marks)
- (d) Based on the results obtained in **Q5 (c)**, plot graph of average unit hydrograph (UH) and label peak discharge and time to peak. (8 marks)
-
- Q6** (a) List **FOUR (4)** usages of flood routing method. (4 marks)
- (b) Explain briefly the Puls method for reservoir routing. (5 marks)
- (c) **TABLE Q6 (c)** tabulates inflow and outflow hydrographs that were observed in a river reach. By using Muskingum routing equation,
- (i) Calculate the storage applicable to this reach. (8 marks)
- (ii) Determine the value of K if $x = 0.31$. (8 marks)

– END OF QUESTIONS –

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TABLE Q1 (c): Hydraulic conductivity in layers

| Layer | Hydraulic conductivity
(cm/hour) | Depth (m) |
|-------|-------------------------------------|-----------|
| 1 | 5.5 | 4.5 |
| 2 | 3 | 9.2 |
| 3 | 1.0 | 17.4 |
| 4 | 1.6 | 2.5 |

TABLE Q1 (d): Hydraulic conductivity

| Material | Hydraulic conductivity (m/day) |
|---------------------------|--------------------------------|
| Gravel, coarse | 150 |
| Gravel, medium | 270 |
| Gravel, fine | 450 |
| Sand, coarse | 45 |
| Sand, medium | 12 |
| Sand, fine | 2.5 |
| Silt | 0.08 |
| Clay | 0.0002 |
| Sandstone, fine-grained | 0.2 |
| Sandstone, medium-grained | 3.1 |
| Limestone | 0.94 |

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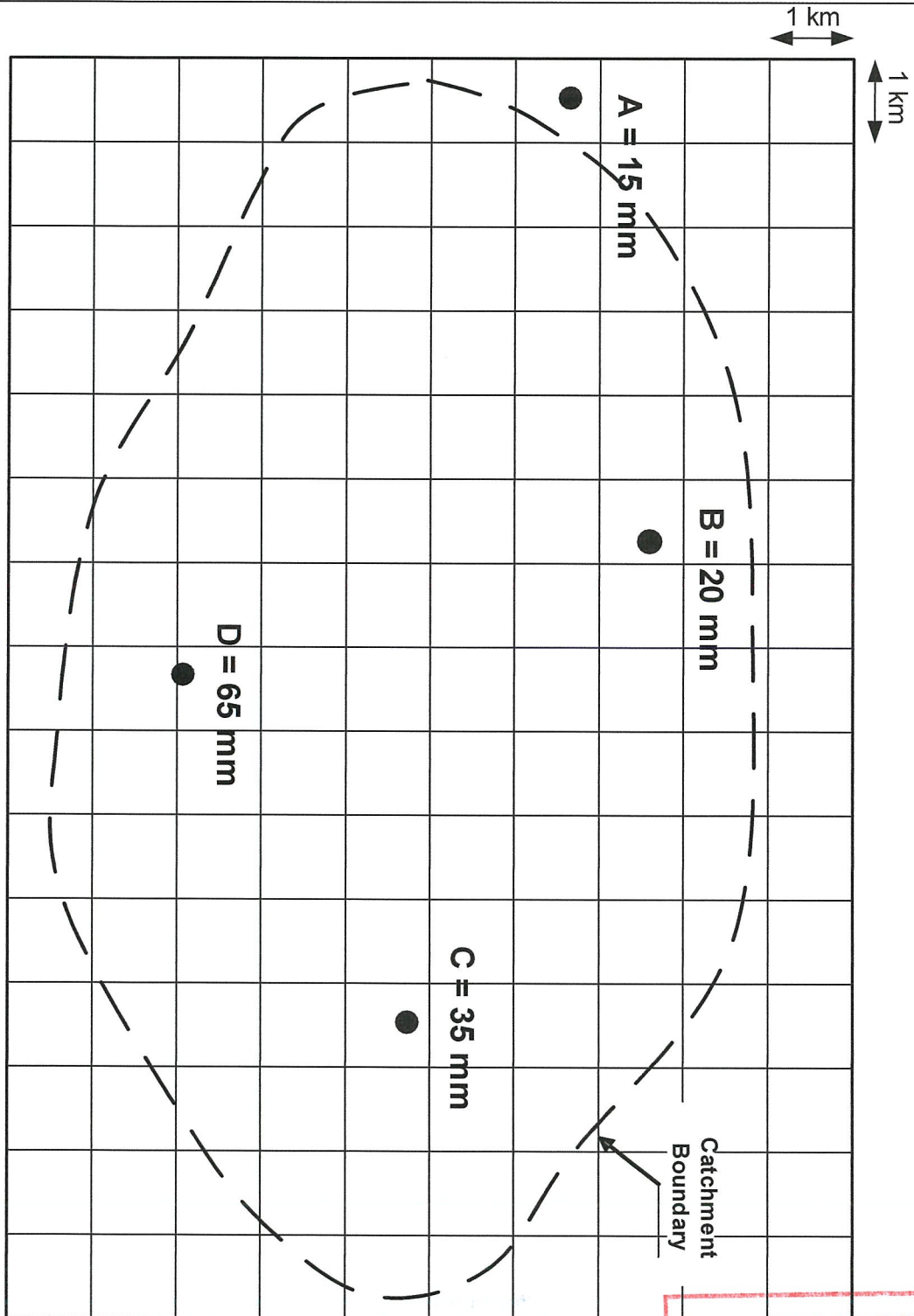


FIGURE Q2 (d): Hydrology Cycle

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TABLE Q4 (d): Data of stream

| Distant from left of water edge, b (m) | Depth (cm) | Rotation N at 0.6d (rev) | Duration of observations (sec) |
|--|------------|--------------------------|--------------------------------|
| 0 | 0 | 0 | 0 |
| 5 | 200 | 58 | 100 |
| 8 | 230 | 80 | 150 |
| 11 | 270 | 112 | 100 |
| 13 | 200 | 90 | 100 |
| 16 | 150 | 45 | 100 |
| 20 | 0 | 0 | 0 |

TABLE Q5 (c): Hydrograph Data

| Duration (hr) | Storm 1 (m ³ /s) | Storm 2 (m ³ /s) |
|---------------|-----------------------------|-----------------------------|
| 0 | 0.00 | 0.00 |
| 1 | 0.70 | 4.70 |
| 2 | 2.50 | 15.50 |
| 3 | 7.40 | 21.20 |
| 4 | 14.30 | 16.60 |
| 5 | 18.70 | 13.20 |
| 6 | 17.00 | 10.00 |
| 7 | 12.10 | 7.40 |
| 8 | 9.10 | 5.50 |
| 9 | 7.00 | 4.00 |
| 10 | 5.20 | 2.70 |
| 11 | 3.80 | 1.70 |
| 12 | 2.50 | 1.50 |
| 13 | 1.50 | 0.80 |
| 14 | 0.70 | 0.20 |
| 15 | 0.00 | 0.00 |

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PEPERIKSAAN AKHIR

SEMESTER/SESSION : SEM I / 2018/2019
 NAMA KURSUS : HYDROLOGY

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TABLE Q6 (c): Inflow and Outflow

| | | | | | | | | | | | | |
|----------------------------------|----|----|-----|-----|-----|-----|-----|-----|-----|----|----|----|
| Time (hours) | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 |
| Inflow (m³/s) | 20 | 80 | 210 | 240 | 215 | 170 | 130 | 90 | 60 | 40 | 28 | 16 |
| Outflow (m³/s) | 20 | 20 | 50 | 150 | 200 | 210 | 185 | 155 | 120 | 85 | 55 | 23 |

FORMULAE:

$$\bar{K} = \frac{D}{\left(\frac{b_1}{K_1}\right) + \left(\frac{b_2}{K_2}\right) + \left(\frac{b_3}{K_3}\right) + \dots + \left(\frac{b_n}{K_n}\right)}$$

$$T = \bar{K}b$$

$$P = \sum_{i=1}^n w_i p_i$$

$$f = f_c + (f_o - f_c)e^{(-kt)}$$

$$Q = \frac{C.i.A}{360}$$

$$Q = \frac{(C_1 - C_2)}{(C_2 - C_0)} q$$

$$\Delta A_1 = \bar{W}_1 y_1$$

$$\text{Run-off depth} = \frac{\text{Run-off volume}}{\text{Catchment area}}$$

$$xI + (1-x)O$$

$$t_1 = \frac{L}{C + V_p}$$

$$t_2 = \frac{L}{C - V_p}$$

$$H^2 - h^2 = \frac{Q}{\pi K} \ln \frac{R}{r}$$

$$P_x = 1/M \times \Sigma(P_i)$$

$$P_x = N_x/M \times \Sigma[P_i/N_i]$$

$$V = \frac{L}{2 \cos \theta} \left[\frac{1}{t_1} - \frac{1}{t_2} \right]$$

$$Q = \sum_{i=1}^{N-1} \Delta Q_i$$

$$\bar{W}_1 = \frac{\left[W_1 + \frac{W_2}{2} \right]^2}{2W_1}$$

$$S_2 = S_1 + \Delta t \left[\frac{I_1 + I_2}{2} - \frac{O_1 + O_2}{2} \right]$$

$$W_i = \frac{(1/L_i^2)}{\sum_{i=1}^n (1/L_i^2)}$$

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