



KARATINA UNIVERSITY

UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER SUPPLEMENTARY/ SPECIAL EXAMINATION

FOR THE DEGREE OF:

BACHELOR OF EDUCATION SCIENCE

COURSE CODE: MAT 424

COURSE TITLE: FLUID MECHANICS III

DATE: Mon 15th July 2024

TIME: 9 – 11AM

INSTRUCTION TO CANDIDATES

1. ANSWER QUESTIONS IN **SECTION A** AND ANY OTHER TWO QUESTIONS FROM **SECTION B**
2. DO ALL YOUR WORKINGS ON THE ANSWER BOOKLET PROVIDED
3. STRICTLY NO USE OF MOBILE PHONES IN THE EXAMINATION ROOM

SECTION A:

QUESTION ONE (30 marks)

- (a) Distinguish between the different forms of precipitation. (5 marks)
- (b) A storm with 10.0 cm precipitation produced a direct runoff of 5.8 cm. Given the time distribution of the storm as below, estimate the ϕ -index of the storm. (6 marks)

Time from start (hr)	1	2	3	4	5	6	7	8
Incremental rainfall in each hour (cm)	0.4	0.9	1.5	2.3	1.8	1.6	1.0	0.5

- (c) The following table shows rainfall observations taken for a certain area. Estimate the mean basin precipitation. (6 marks)

Isohyets (in)	Total area enclosed within basin boundary (ha)	Estimated precipitation between isohyets
> 6	50	6.3
> 5	120	5.5
> 4	250	4.7
> 3	450	3.6
> 2	780	2.7
> 1	999	1.4
< 1	1020	0.8

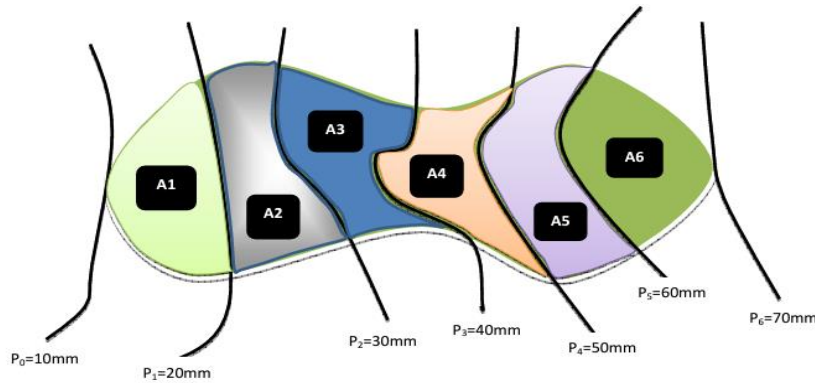
- (d) Rainfall of intensity 20mm/hr occurred over a watershed of area 1km² for a duration of 6 hours. The volume of run-off in the stream was measured to be 30,000m³. Find the precipitation not available for run-off. (3 marks)
- (e) Normal annual rainfall at stations A, B and C situated in meteorologically homogeneous region are 170 cm, 190 cm and 150 cm respectively. In a certain year, station A was inoperative and stations B and C recorded annual precipitation of 160 cm and 140 cm respectively. Estimate the rainfall at station A in that year. (3 marks)
- f) Give three factors to consider when choosing a model for watershed modeling. (3 marks)
- g) Check whether continuity is satisfied by the following fields. (4 marks)
- i) $u = x^2y + y^3$, $v = x^3 - xy^2$
- ii) $u = x^2y$, $v = 2yz - xy^2$, $w = x^2 + z^2$

SECTION B

QUESTION TWO (20 marks)

- a) For a given month, a 121 ha lake has 0.43 m³/s of inflow, 0.37 m³/s of outflow, and the total storage increase of 1.97 ha-m. A USGS gauge next to the lake recorded a total of 3.3 cm precipitation for the lake for the month. Assuming that infiltration loss is insignificant for the lake, determine the evaporation loss, in cm over the lake for the month. (7 marks)

- b) Use the isohyetal method to determine the average precipitation depth within the basin for the storm. (7 marks)



- (c) State the steps followed in watershed modelling. (6 marks)

QUESTION THREE (20 Marks)

- At a particular time, the storage in a river reach is $60 \times 10^3 \text{ m}^3$. At that time, the inflow into the reach is $10 \text{ m}^3/\text{s}$ and the outflow is $16 \text{ m}^3/\text{s}$. After two hours, the inflow and the outflow are $18 \text{ m}^3/\text{s}$ and $20 \text{ m}^3/\text{s}$ respectively. Determine the change in storage during two hours period and the storage volume after two hours. (6 marks)
- A 3-hour storm on a small drainage basis produced rainfall intensities of 3.5 cm/hr , 4.2 cm/hr and 2.9 cm/hr in successive hours. If the surface run-off due to the storm is 3 cm , find the value of Φ index. (3 marks)
- A canal is 80 km long and has an average surface width of 15 m . If the evaporation measures in class A pan is 0.2 cm/day , the volume of water evaporated in a month of 30 days in m^3 . (3 marks)
- Discuss different forms of precipitation. (3 marks)
- A water catchment basin has an area of 8000 m^2 , annual precipitation of 20 m/yr ; average annual streamflow $R = 5000 \text{ cm}^3/\text{s}$. Use the water budget method to obtain an estimate of annual evapotranspiration in the basin. (Assume the system is steady state). (5 marks)

QUESTION FOUR (20 marks)

- One of four monthly-read rain gauges on a catchment area develops a fault in a month when the other three gauges record 48 , 58 and 69 mm respectively. If the average annual precipitation amounts of these three gauges are 741 , 769 and 855 mm respectively and of the broken gauge 707 mm , estimate the missing monthly precipitation at the latter. (5 marks)

- b) A reservoir with a surface area of 250 ha had the following parameters: water temp. 22.5°C, RH = 40%, wind velocity at 9.0 m above the ground = 20 km/hr. Estimate the volume of the water evaporated from the lake in a week. Given
 $e_w = 20.44$, $K_m = 0.36$. (4 marks)
- c) State and briefly explain four factors affecting infiltration rate and capacity. (6 marks)
- d) In a field test of a formation having a porosity of 25%, the hydraulic gradient was found to be 0.04, and the velocity of the tracer added to the ground water was 6m/h. Find the permeability of the aquifer. (5marks)

QUESTION FIVE (20marks)

- a) Find area precipitation by isohyetal method for a certain catchment area given the following data. (5 marks)

Isohyet, in	Area enclosed within basin boundary, sq. mile
6.8	
6	20
5	97
4	213
3	410
2	602
1.5	633

- b) A direct run-off hydrograph due to a storm idealized into a triangular shape has a peak flow rate of 60m³/s occurring at 25 hours from its start. If the base width of this hydrograph is 72 hours and the catchment area is 777.6 Km², find the run-off from the storm. (5 marks)
- e) A culvert is designed for a flood frequency of 100 years and a useful life of 20 years. Calculate the risk involved in designing the culvert in percentage. (3 marks)
- f) An inflow hydrograph is measured from a cross-section of a stream as shown in the table below. Compute the outflow hydrograph at a point downstream using Muskingum method given that $x = 0.35$ and $k = 1.2$ days. The initial outflow at B was 10 m³/s. (7 marks)

Time(hr)	2.0	4.0	6.0	8.0	10.0
Inflow(m ³ /s)	80	180	140	75	25