



MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 502: WATER RESOURCES ENGINEERING I

DATE: 14TH JANUARY, 2025

TIME: 11.00 AM – 1.00 PM

INSTRUCTIONS:

*Answer question **ONE (Compulsory)** and **any other TWO** questions*

Necessary tables and charts are provided in the appendix at the end of the questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Differentiate between;
- i) Single purpose reservoir and multi-purpose reservoir
 - ii) Base load and peak load in hydropower generation
 - iii) Coefficient of permeability and coefficient of transmissibility in groundwater
 - iv) Hydraulic fill dams and homogeneous earth dams. (8 Marks)
- b) Define water resources engineering and discuss the importance of the knowledge of water resources engineering. (5 Marks)
- c) The following data are available for a river valley project reservoir.

Table Q1

Catchment area = 1000 km²

Live storage = 7930 ha.m

Dead storage = 3570 ha.m

Annual average suspended load = 35 ha.m

The total suspended load has the following grade:

Coarse = 10 per cent

Medium = 20 per cent

Fine = 70 per cent

Assume that all coarse sediment, 80 percent of the medium silt and 20 percent of fine silt would be deposited in the reservoir. Bed load at 10 percent of the total sediment load would also be trapped in the reservoir.

Estimate:

- i) The useful life of the reservoir (4 Marks)
- ii) The ultimate life of the reservoir (2 Marks)
- iii) State any assumptions made (1 Mark)

d) Describe the following type of hydropower plants.

- i. Dam power plants
- ii. Pumped storage
- iii. Run-of river plant. (10 Marks)

QUESTION TWO (20 MARKS)

The monthly net flow into a reservoir during a critical flow period is listed in Table Q2.

- a) What is the smallest reservoir capacity that should be constructed to satisfy an average monthly demand of 700 m³. (15 Marks)
- b) What is the capacity of the largest reservoir that can be constructed on the stream? (3 Marks)
- c) What is the yield in (b) above? (2 Marks)

Table Q2

1981		1982		1983	
Month	Flow (x 100) m ³	Month	Flow (x 100) m ³	month	Flow (x 100) m ³
February	21.6	February	6.0	February	18.0
March	26.4	March	7.2	March	20.4
April	20.4	April	7.2	April	30.0
May	31.2	May	6.0	May	56.4
June	18.0	June	3.6	June	19.2
July	38.4	July	2.4	July	21.6
August	9.6	August	1.2	August	8.4
September	3.6	September	0	September	4.8
October	0	October	0	October	0
November	0	November	0	November	1.2
December	0	December	0	December	3.6
January	0	January	8.4	January	4.8

QUESTION THREE (20 MARKS)

A Type II reservoir has the following data:

Normal reservoir level = 70 m

Stream bed elevation at dam = 53.5

Period of sedimentation = 10 years

Sedimentation accumulation over the period = 1750 ha.m

Table Q3: Reservoir area

Elevation (m)	Area (ha)
53.50	0
55.00	45
56.50	70
58.00	140
59.50	185
61.00	350

Elevation (m)	Area (ha)
62.50	540
64.00	675
65.50	850
67.00	1000
68.50	1200
70.00	1400

The elevation of the sediment deposited at the new zero elevation is 58.38 m

a) Determine the accumulated sediment volume at different elevation of the reservoir.

(16 Marks)

b) Determine the revised capacity of the reservoir after allowing for sediment deposit.

(4 Marks)

QUESTION FOUR (20 MARKS)

With aid of a well labelled sketch derive an equation of steady radial flow in a free surface aquifer, and state the assumptions made.

(10 Marks)

The distance-drawdown data on three observation wells during a pump test in Machakos University are given in Table Q4. The drilling log indicated silty clay up to a depth of 25 m underlain by a 30 m thick medium sand, followed by fine sand and clayey sediments. The well screen was installed for the entire thickness of medium sand. The well was pumped at the rate of 2667 litres per minute for 24 hours till the drawdown became steady.

i) Present the problem in a well labelled sketch.

(5 Marks)

ii) Determine the aquifer constants.

(5 Marks)

Table Q4

Distance of observation well (m)	1.5	35	95
Drawdown (m)	1.9	0.6	0.15

QUESTION FIVE (20 MARKS)

Table Q5 lists flood stages and the flooding damages that have been found to occur during floods of the indicated stage. Column 3 presents the percentage chance that a flood can equal or exceed that stage. Column 4 presents the annualized cost of constructing a levee high enough to prevent all flooding by a flood of the indicated state. Is it economically feasible to construct a levy? If it is feasible, to what height should it be constructed for

- The maximum benefit
- The most economical solution

Table Q5

Flood Stage with no protection (ft)	Damage for one flood at stage (000s KES)	Chance that flood could be exceeded	Annual cost of constructing a levy to prevent flooding (000s KES)
35	0	49.50	0
36	100,000	41.50	4,000
37	200,000	33.50	9,000
38	300,000	25.50	14,000
39	450,000	18.50	22,000
40	600,000	13.50	31,000
41	800,000	9.10	41,000
42	1,000,000	5.78	51,000
44	1,250,000	2.53	71,000
46	1,550,000	0.95	91,000
48	1,950,000	0.30	121,000
50	2,450,000	0.10	151,000
52	3,950,000	0.05	191,000
Above 52	6,150,000	0.0	-----

APPENDIX

Table A1. Types and characteristics of reservoirs

Type	Description	Slope of line of capacity vs depth	Position of deposition	C	m	n
I	Lake	3.5 – 4.5	Top	5.074	1.85	0.36
II	Flood plain-foot hill	2.5 – 3.5	Upper middle	2.489	0.57	0.41
III	Hill	1.5 – 2.5	Lower middle	16.967	1.15	2.32
IV	Gorge	1 – 1.5	Bottom	1.486	0.25	1.34

