



MACHAKOS UNIVERSITY

University Examination 2019/2020

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING
FIFTH YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 502 WATER RESOURCES ENGINEERING I

DATE: 13/12/2019

TIME: 2.00-4.00 PM

INSTRUCTIONS

Answer Question One and Any Other Two Questions

Use sketches and/or equations, where necessary, to illustrate your answers.

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Distinguish between:
- i. Useful life and ultimate life of a reservoir (3 marks)
 - ii. Water table and piezometric surface (3 marks)
 - iii. Load factor and capacity factor in hydropower development (3 marks)
 - iv. Diversion dam and detention dam (3 marks)
- b) Describe the principle governing the operation of multipurpose reservoir (5 marks)
- c) Describe the reservoir operation for flood control (5 marks)
- d) The following data for a river valley project reservoir are available:
- Total reservoir capacity = 12200 ha.m
 - Dead storage = 35700 ha.m
 - Live storage = 8630 ha.m
 - Annual average suspended load = 30 ha.m
 - The suspended load has the following grade:
 - Coarse = 3%

Medium = 21%

Fine = 76%

Assume that all the coarse sediment, 80% of medium silt and 20% of fine silt would be deposited in the reservoir. Further, bed load at 10% of the total sediment load would also be trapped in the reservoir. Estimate:

- i. The useful life of the reservoir
- ii. Full life of the reservoir (8 marks)

QUESTION TWO (20 MARKS)

- a) With aid of a well labelled sketch, derive an equation of discharge from unconfined aquifer under steady-state drawdown conditions and constant pumping rate (10 marks)
- b) The distance drawdown data on three observation wells during a pump test are given in Table Q2. The drilling log indicated silty clay up to a depth of 25 m underlain by a 30 m thick medium sand, followed by fine sandy and clayey sediment. The well screen was installed for the entire thickness of medium sand. The well pumped at the rate of 160 m³/hr for 20 hours till the drawdown became steady. Determine the aquifer constants (10 marks)

Table Q2

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

QUESTION THREE (20 MARKS)

The mass curve of available water during the critical dry period at a given storage reservoir is as listed in Table Q3

Table Q3

Month	Flow (m ³)	Flow (m ³)
	1993	1994
March	0	950
April	125	1000
May	313	1125
June	513	1263
July	750	1375
Aug	938	1400

Month	Flow (m ³)	Flow (m ³)
	1993	1994
September	1063	1313
October	1125	1288
November	1113	1363
December	1063	1500
January	1000	1750
February	950	2375

- a) What continuous constant yield (in m³/year) is possible with a reservoir having a storage capacity of 50,000 m³?
- b) What storage capacity (in m³/year) is required for a constant yield rate of 600 litres per month?

QUESTION FOUR (20 MARKS)

- a) Describe the following classes of hydropower plants (10 marks)
- Dam Power Plants
 - Run-of-river plants
 - Pumped storage plants
 - Diversion canal plants
- b) A run-of-river station has an installed capacity of 20000 kW and has a load factor of 20% while operating as a peak load station.
- If the plant efficiency is 80% when working under a head of 18 m, what would be the minimum discharge of the river so that the station may serve as a base load station? (5 marks)
 - What would be the load factor of the plant if the discharge of the river rises to 25 cumecs? (5 marks)

QUESTION FIVE (20 MARKS)

A reservoir has the following data:

- Original capacity = 8250 ha.m
- Normal reservoir level = 175.50 m
- Period of sedimentation = 15 years
- Sedimentation accumulation over the period = 1750 ha.m
- Characteristics of sediments: sandy with patches of clay
- Stream bed elevation at dam = 160.00 m

Reservoir area and capacity data are as given in Table Q5

Elevation (m)	Area (ha)	Capacity (ha.m)
160.00	0	0
161.75	45	60
162.70	70	125
163.75	140	240
165.00	185	445
166.50	350	710

Elevation (m)	Area (ha)	Capacity (ha.m)
168.00	540	1320
169.50	675	2225
171.00	850	3375
172.50	1000	4825
174.00	1200	6500
175.5	1400	8250

If the elevation of the sediment deposited at the new zero elevation is 163.875 m, determine:

- The accumulated sediment volume at different elevations of the reservoir (15 marks)
- The revised capacity of the reservoir after allowing the sediment deposit (5 marks)