MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 502: WATER RESOURCES ENGINEERING I

DATE: 9/8/2021 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

- *This paper comprises of five questions. Answer **three** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer 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) With aid of well labelled sketches differentiate between:

i. A water table and piezometric surface (5 marks)

ii. Gross head and effective head for a hydro-electric plant (5 marks)

b) The following data in Table Q1 is 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)

c) With aid of a well labelled sketch explain the components parts of an earth dam and their functions. (13 marks)

QUESTION TWO (20 MARKS)

A horizontal layer of sand of 6.2 m thickness is overlain by a layer of clay with a horizontal surface of thickness 5.8 m. An impermeable layer underlies the sand. In order to carry out a pumping test, a well was sunk to the bottom of the sand and two observation wells sunk through clay just into the sand at distances of 14 m and 52 m from the pumping well. After a long constant pumping rate of 650 litres/min., the water levels in the observation wells were reduced by 2.31 m and 1.82 m respectively.

a) Present the problem set-up in a well-labelled sketch. (8 marks)

b) Calculate the coefficient of permeability of the sand if the initial piezometric surface level lies 1.0 m below the ground surface. (8 marks)

c) Estimate the radius of influence. (4 marks)

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)

a) 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)

b) 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 gives average monthly flows for a critical twelve month period at a proposed reservoir site.

Table Q5

Month	Mean flow (m3/h)
Mar	67
Apr	201
May	13
June	7
July	54
August	203

Month	Mean flow (m3/h)
September	70
October	20
November	49
December	150
January	69
February	44

If the monthly demand is 40,000 m3:

a) Use the mass curve diagram and determine the required live storage capacity of the reservoir (14 marks)

b) Determine the gross storage capacity if the dead storage volume is to be 12.5 percent of the live storage. (1 mark)

c) With aid of sketches and the mass-curve diagram in (a) above, show and describe the variation of the water levels in the reservoir through a wet year. (5 marks)

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