MACHAKOS UNIVERSITY

University Examinations for 2021/2022 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 RESOURCE ENGINEERING I

DATE: 22/8/2022 **TIME: 11.00-1.00 PM**

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 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)

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

SECTION B: Answer ANY TWO questions (*40 Marks*)

QUESTION TWO (20 MARKS)

A city engineer estimates the hourly demand for water on the maximum day as listed in Table Q2. Water is pumped from a treatment plant to a supply reservoir at a uniform rate for the 24 hours.

a) What pump capacity is required? (4 marks)

b) Using the mass-curve method determine the capacity of the reservoir required. (10 marks)

c) Present the time-series of the amount of water in reservoir and indicate the time at which the amount of in the reservoir is at maximum. (6 marks)

Table Q2

Hour ending	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00
Demand (l/s)	830	740	650	640	630	650	670	790

Hour ending	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
Demand	900	990	1000	1010	1020	1040	1050	1030

Hour ending	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00
Demand	1035	1040	1040	1070	1090	1105	1070	1000

QUESTION THREE (20 MARKS)

A Type II reservoir has the following data:

Normal reservoir level = 70 m

Stream bed elevation at dam = 53.5m

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 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 sand and clayey sediments. The well screen was installed for the entire thick ness 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 Q2

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

QUESTION FIVE (20 MARKS)

An earth dam made of homogeneous material has the following data:

- Coefficient of permeability of dam material = 8 x 10-3 cm/sec
- Level of top of dam = 200.0 m
- Level of deepest river bed = 288.0 m
- Free board = 2.0 m
- Top width of the dam = 4 m
- Upstream slope = 5:2
- Downstream slope = 2:1

a) Determine and construct the base parabola and the phreatic line (14 marks)

b) Estimate the discharge by (a) analytical method and (b) the flow nets (6 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