



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 522: DESIGN & CONSTRUCTION OF DAMS

DATE: 21ST JANUARY, 2025

TIME: 11.00 AM – 1.00 AM

INSTRUCTIONS:

Answer question ONE (Compulsory) and any other TWO questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Giving an example for each, state the main classification for dams. (2 Marks)
- b) The Ndakaini dam is 63 m high, 458 m crest length earth fill supplying Nairobi County and its environs with water. Check whether a top crest width of 12 m would be adequate. (3 Marks)
- c) Hydrological considerations are critical when sitting in a dam. Explain any THREE. (3 Marks)
- d) Ground investigations must be conducted before designing and construction of a dam. Discuss. (4 Marks)
- e) An earthquake that has occurred in the vicinity of a dam site has caused vertical acceleration acting downwards. If the *dam weight* = 73130 kN , calculate the net effective weight, W_e of the dam if $k_v = 0.2(-)$ (3 Marks)
- f) Discuss the importance of selecting appropriate rock materials for a rockfill dam. What characteristics should the rock have? (3 Marks)
- g) The principle stress of an elementary profile of a gravity dam varies only with height of the dam. Discuss this statement (3 Marks)

- h) A flow net is plotted for a homogeneous earthen dam of height 22m and freeboard 2.0m. The results obtained are:

Number of potential drops = 10

Number of flow channels = 4

The dam has a horizontal filter of 30m length at the downstream end and the coefficient of permeability of the dam material is $5 \times 10^{-4} \text{ cm/sec}$. Calculate the discharge per m run of the dam.

(3 Marks)

- i) Explain the methods used to control seepage in earth-fill dams and why seepage control is critical to the stability of the structure

(2 Marks)

- j) For an earth-fill dam with a slope angle of 1.3:1 on the downstream face and a height of 30 meters, calculate the factor of safety (FOS) against sliding using given soil properties: Unit weight, $\gamma = 18 \text{ kN/m}^3$; soil cohesion, $C = 15 \text{ kPa}$.

(4 Marks)

QUESTION 2 (20 MARKS)

- a) Define (i) gravity dam (ii) earth dam

(4 Marks)

- b) A rockfill dam experiences settlement due to large void spaces in the material. If the dam height is 40 meters and the compressibility coefficient is $1 \times 10^{-4} \text{ m/kPa}$, estimate the settlement after a water load of 1000 kPa is applied.

(4 Marks)

- c) A dam is subjected to hydrodynamic pressure with $H = 60\text{m}$ and specific gravity $S_c = 2.4$. Calculate the shear stress at the toe.

(4 Marks)

- d) Discuss at any ONE geophysical method of ground investigation.

(4 Marks)

- e) For a dam with a height $H=70 \text{ m}$, with a drainage gallery at $H' = 40\text{m}$, calculate the uplift pressure at the base using the USBR recommendations.

(4 Marks)

QUESTION 3 (20 MARKS)

- a) Discuss TWO environmental considerations when selecting the site of a dam

(4 Marks)

- b) The area of a dam section is 1409m^2 . If the bottom width of the is 114.5m, the dry weight of the soil in the dam is 18 kN/m^3 , Calculate the average compressive stress at base.

(3 Marks)

- c) Make a logical list of the stages in the planning and design of dams

(4 Marks)

- d) You have been assigned as the design engineer for the Thwake Multipurpose dam at the border of Kitui and Makueni Counties. If your first task is to create a team of project specialists, state the composition of your team and the role of each team member.

(4 Marks)

- e) The water column at the u/s face of a dam is 87m. Calculate the expected moment about the base due to horizontal acceleration of the dam and dam foundation towards the reservoir. Use Von-Karman approach and take $g = 9.81 \text{ m/s}^2$ and $k_h = 0.31$ (5 Marks)

QUESTION 4 (20 MARKS)

- a) Distinguish between buttress and arch dams. (2 Marks)
- b) Compare the advantages and disadvantages of using rockfill dams versus earthfill dams in regions prone to seismic activity. (4 Marks)
- c) For a dam, the design water depth in the upstream and downstream is 80m and 6m respectively.
- (i) Calculate the magnitude of the forces due to the water pressure in the upstream and in the downstream faces of the dam. What is the direction of the net force due to the water? (6 Marks)
- (ii) Calculate the lever arms for the upstream and downstream water forces. What is the resulting moment in each case? Are they stabilizing or destabilizing moments? (8 Marks)

QUESTION 5 (20 MARKS)

- a) State FOUR socio economic considerations when selecting a dam site. (4 Marks)
- b) State the assumptions in 2-D design of gravity dams (4 Marks)
- c) The effect of wind was determined to be significant during the design of the Thwake multipurpose dam. If the maximum wind expected in the area has a speed of 88 km/h, and the wind fetch is 7.5 km, calculate the:
- i) Wave amplitude at the u/s face of the dam (3 Marks)
- ii) Total force Maximum pressure due to wave action (2 Marks)
- iii) If the water column in the upstream face of the reservoir is 50m, calculate the moment at the base of the dam. (3 Marks)
- iv) Calculate the minimum height of the freeboard that must be provided. (2 Marks)
- v) Without considering earthquake forces, use Creager's method to estimate the most economical top width. (2 Marks)