City & Guilds

9210-109
Level 6 Graduate Diploma in Engineering
Irrigation engineering

Sample Paper

You should have the following for this examination
• one answer book

No additional data is attached

General instructions
• This examination paper is of **three hours** duration.
• This examination paper consists of **seven** questions.
• Answer any **five** questions.
• All questions carry equal marks. The maximum marks for each section within a question are given against that section.
• An electronic, non-programmable calculator may be used but candidates **must** show clearly the steps prior to obtaining final numerical values.
• Drawings should be clear, in good proportion and in pencil. Do **not** use red ink.

1 a) i) Illustrate the important components of a lift irrigation scheme using a schematic diagram. (4 marks)

ii) Compare lift irrigation with gravity irrigation with regard to the conveyance efficiency of water supply. (6 marks)

b) 'Lift irrigation is advantageous, when a high ground water table is present'.

i) Do you agree with the above statement? (2 marks)

ii) Support your agreement or disagreement with reasons. (Use sketches where necessary for your explanations.) (8 marks)

2 a) Classify dams depending on their usages and describe briefly each of the types. (6 marks)

b) Justify the statement 'Topography dictates the first choice of the type of dam'. (6 marks)

c) State the main design principle of gravity dams. (2 marks)

d) Explain **three** main forces acting on a masonry gravity dam, in reservoir full condition (Use a neat diagram). (6 marks)

3 a) Siltation is a major issue in irrigation canals. Name and explain working of the structure generally used to prevent silt entering into main canals ahead of head regulators (Neat diagrams are expected). (10 marks)

b) An irrigation canal constructed on earth has a bed width of 1.8 m. The maximum depth of flow allowed is 1.2 m. The canal has slide slopes of 1.5 horizontal to 1 vertical and an average bed slope of 0.0004. Manning's roughness coefficient for earth can be considered as 0.023. Determine the maximum discharge the canal can carry. Manning's equation, $V = 1/n\ (R)^{2/3}\ (S)^{1/2}$ with usual notations. (10 marks)

4 a) Explain briefly, **three** important technical considerations in the installation of a weir plate. (6 marks)

b) Measuring structures are very important in water management. Evaluate the function of a sharp crested rectangular weir with the aid of neat ketches of its longitudinal section and cross section. (14 marks)

5 a) i) Define 'Potential Evapotranspiration (PET) of reference crop'. (4 marks)

ii) Write an expression to indicate the relationship between the 'total rainfall' and the 'effective rainfall' in relation to irrigation water requirement computations. Clearly explain all the terms. (4 marks)

b) Data in Table Q5 are for a 90-day crop grown in an area of 60 hectares. Consider each month has 30 days.

Month	1	2	3
Reference crop PET (mm)	175	160	154
Crop coefficient	1.1	1.2	0.9
Monthly rainfall (mm)	0	100	0

Table Q5

i) If the effective rainfall coefficient is 0.6, estimate the average daily contribution of rainfall towards root zone soil moisture during the second month. (3 marks)

ii) Estimate the monthly crop water requirements for each of the 3 months. (3 marks)

iii) Estimate in hectare metres, the total volume of water required during the three months at the farm (FIR), if the application efficiency is 70%. (6 marks)

6 a) Differentiate between the quantities 'Available Moisture' and 'Readily Available Moisture'. (7 marks)

b) An irrigation scheme has to be designed to cultivate corn and soybeans. The total irrigable area consists of three different types of soils, namely X, Y and Z with the properties as given in Table Q6a. Accordingly, the total irrigable area is divided into three sub areas A, B and C. One sub-area will be used to cultivate one crop (either corn or soybeans). The average crop data are given in Table Q6b. Select two areas for the two crops such that the irrigation intervals will be similar to both crops (Show all computations). (13 marks)

Area	Soil Type	Texture	Percentage Moisture content	
			Field Capacity	Permanent wilting point
A	X	Sandy clay loam	22	13
B	Y	Sandy loam	8	4
C	Z	Clay loam	31	15

Table Q6a

Crop	Average ET (mm)	Average Root Depth (m)
Corn	10.0	1.07
Soybeans	4.5	0.7

Table Q6b

7 a) 'Tile drains' are commonly used as subsurface relief drainage.

i) Explain the term 'Subsurface relief drainage'. (3 marks)

ii) Explain the working of 'tile drains' using a neat sketch. Inflow paths to the tile drain and 'water table' should be indicated. (5 marks)

b) Justify the use of 'furrow irrigation' to grow crops. Your answer should indicate the following:

i) A cross-section view of the furrows with approximate dimensions and flow directions.

ii) Principle of water movement.

iii) Advantages and limitations. (12 marks)