

OLLSCOIL NA hÉIREANN, GAILLIMH  
NATIONAL UNIVERSITY OF IRELAND, GALWAY

B.E. Degree – Civil Engineering/Environmental Engineering

EH 406 – Engineering Hydrology I  
Semester I Examinations 2000

Examiners: Professor P.E. O'Connell  
Professor C. Cunnane

*Time allowed: Two hours*  
*Attempt four questions*

1. (a) State what is understood by the Greenhouse Effect and how this is purported to play a role in climate change. *[4.5 marks]*
- (b) Discuss the predicted effects of climate change (if any) in the context of
  - (i) Global temperature over the next century
  - (ii) Irish weather patterns
  - (iii) World water resources, food production and population shifts
  - (iv) Floods in Ireland and other parts of the world. *[2 marks each]*
2. (a) Describe two types of investigation in which application of the technique of reservoir flow routing is appropriate. *[4 marks]*
- (b) List the four separate types of information which needs to be assembled for a reservoir flow routing application. *[4 marks]*
- (c) A storage volume – outflow relation of a particular reservoir is

$$S = 0.0184 + 0.1086Q - 0.0052Q^2$$

where  $S$  is in million  $m^3$  and  $Q$  is in  $m^3/s$ . If the following outflows were observed calculate the corresponding lumped inflows for times 3, 6 and 9 hours. *[4.5 marks]*

Time (hours)	0	3	6	9	12
$Q(m^3/s)$	0	0.62	1.75	3.22	5.92

*Continued overleaf.../*

3. (a) Define what is meant by a unit hydrograph [2 marks]

- (b) A one hour effective rainfall on a catchment of area  $30 \text{ km}^2$  produced the following quick response runoff,  $q$ :

Time(hours)	0	1	2	3	4	5	6
$q \text{ (m}^3/\text{s)}$	0	15	60	90	70	30	0

Determine the ordinates of the 1 cm 1 hour unit hydrograph for the catchment. [6 marks].

- (c) Write down the convolution equation(s) for total runoff from a series of effective rainfalls  $r_1, r_2, \dots, r_n$  on a catchment whose unit hydrograph ordinates are  $u_0, u_1, u_2 \dots u_m$ . [2 marks]

Use this to calculate peak runoff from a storm of successive 1 hour effective rainfall amounts of 2 cm, 6 cm, 6 cm and 3cm on a catchment whose 1 hour UH ordinates, in  $\text{m}^3/\text{s}$ , are

0.0, 11, 37, 56, 44, 19, 0

[2.5 marks]

4. (a) In the context of groundwater hydrology define the terms **aquifer**, **water table**, **potentiometric surface**, **storativity** and **specific yield** [5 marks]

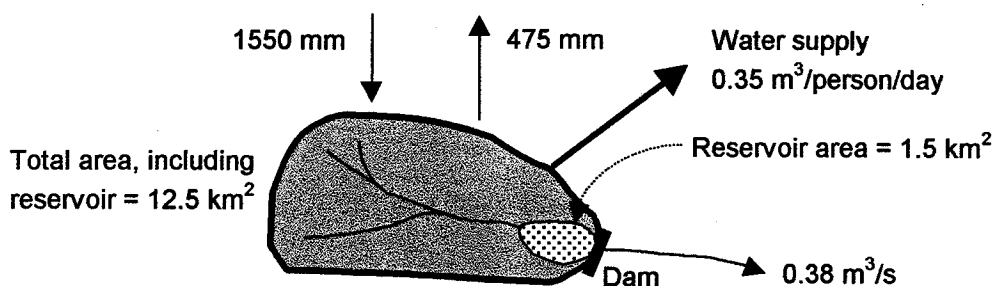
- (b) Is Darcy's Law for groundwater flow based on the assumption that flow is laminar or turbulent? Explain your answer. [2.5 marks]

- (c) A homogenous aquifer which is 25 m thick has a transmissivity of  $225 \text{ m}^2/\text{day}$  and a storativity of 0.0044. If a well installed in the aquifer is pumped at the rate of  $3500 \text{ m}^3/\text{day}$  determine the drawdown in a monitoring well located 60 m from the well two days after the commencement of pumping. [5 marks]

5. (a) A flood wall is constructed to withstand the flow of return period 100 years. Calculate the hydrological risk associated with this design over a 25 year design life. [2.5 marks]
- (c) A series of annual minimum flows, in  $\text{m}^3/\text{s}$ , has logarithms, to base 10, whose mean = 0.48 and standard deviation = 0.15. Stating your assumptions calculate the low flow value of return period 20 years. [3 marks]
- (d) Display the following 8 values of annual maximum flows on an Extreme Value Type 1 (EV1) probability plot and show on it (i) a return period scale and (ii) the line  $Q = u + \alpha y$  where ( $u, \alpha$ ) are the EV1 parameters estimated by method of moments,  $Q$  = flow magnitude and  $y$  is EV1 reduced variate. [7 marks]

Q values:	65	188	224	102	71	53	74	42
Ranked values:	42	53	65	71	74	102	188	224
Summary Statistics: Mean = 102.4, Standard Deviation = 67.0								

6. (a) An upland catchment received 1550 mm of rain in a particular year. Its area to a dam location is  $12.5 \text{ km}^2$ . This area includes a water supply reservoir of area  $1.5 \text{ km}^2$ . If a water supply for a town of 6500 people was extracted at the rate of  $0.35 \text{ m}^3/\text{person}/\text{day}$  (350 litre/person/day) calculate the drop in reservoir water level during the year if mean outflow from the reservoir over the year was  $0.38 \text{ m}^3/\text{s}$ . Assume that evaporation took place at the same rate over both the reservoir and over the unreservoired portion of the catchment. [4 marks]



- (b) In the context of air humidity explain what the term *psychrometric constant* means [2 marks]
- (c) If air humidity is 70%, dry bulb air temperature is  $15^\circ\text{C}$  and wind speed at 2 m elevation is  $1.4 \text{ m/s}$  calculate the aerodynamic component of evaporation,  $E_a$  expressing it in  $\text{mm}/\text{day}$  and in  $\text{kJ}/\text{m}^2/\text{day}$ . [6.5 marks].