

OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

B.E. Degree – Civil Engineering
 Environmental Engineering

EH 407 – Engineering Hydrology II

SUMMER EXAMINATIONS 2005

Examiners: Professor K.J. Beven
 Professor C. Cunnane

Time allowed: Two hours
Attempt four questions

1. (a) Explain what is meant by the unit hydrograph of duration T and why it can be obtained as $U(T, t) = \frac{1}{T} [S(t) - S(t - T)]$. [4 marks]
- (b) If the ordinates of a 1 cm 1 hour unit hydrograph, at hourly intervals in m^3/s , are
 0.0, 0.9, 3.9, 6.2, 5.0, 2.9, 1.6, 0.9, 0.4, 0.0
 determine the ordinates of the 2 hour unit hydrograph. [5 marks]
- (c) What is the area of the catchment? [1.5 marks]
- (d) Contrast briefly the effect of data errors on
 (i) the UH convolution process and
 (ii) the UH derivation process. [2 marks]
2. (a) A water supply is currently being extracted from a lake. It is proposed to increase this by amount Δq . Assuming that there is a gauging station at the lake outlet, the lake water level–outflow relationship is known and a record of flows exists explain how flood routing procedures could be used to investigate the effect of the increased abstraction. [4 marks]
- (b) A lake has a surface area of 3 km^2 and for a particular investigation it is assumed to have vertical sides. Its outflow is controlled by a Crump weir of length 6.122m, perpendicular to direction of flow, i.e. $Q = 12 H^{3/2}$.
 An inflow hydrograph at times 0, 12 and 24 hours has ordinates 50, 80 and $130 \text{ m}^3/\text{s}$. Assuming that initial lake water level is $H = 0.5 \text{ m}$ above the weir crest calculate the outflows at times 0 and 12 hours. You may use any method of routing, piecewise linear or Puls. [8.5 marks]

3. (a) Explain what is meant by skewness in hydrological data and define coefficient of skewness and coefficient of L-skewness. [3 marks]

- (b) A river has annual maximum floods whose statistics are

$$\bar{Q} = 200 \text{ m}^3 / \text{s}, \sigma = 90 \text{ m}^3 / \text{s}, g = 2.3$$

Using Harter's table for frequency factor $K_T(g)$ calculate Q_T for $T = 10, 50$ and 100 year return period and display the values on an EV1 base.

[6.5 marks]

- (c) Explain the relationship between $K_T(g)$ above and the reduced variable y_T in the two parameter gamma distribution. [3 marks]

4. (a) Explain the following:

- Soil moisture tension
- pF
- soil moisture characteristic
- soil moisture deficit
- tensiometer
- "neutron probe"

[6 marks]

- (b) In the context of evaporation from dry soils explain the Penman and Thornthwaite assumptions about the manner in which the ratio $E_{\text{actual}}/E_{\text{potential}}$ varies with soil moisture state.

[3 marks]

If at the beginning of June SMD = 100 mm and June PE and rainfall amounted to 90 mm and 20 mm respectively, what is the Penman estimate of actual evaporation for June, in a grass covered catchment? [3.5 marks]

5. (a) What is meant by the term catchment characteristic? Outline the main categories of catchment characteristics. By what other term or name are they also known? [3 marks]

- (b) What advantage/disadvantage do expressions of the following form have?
 \bar{Q} or $Q_{\text{med}} = C A^a$ or

$$\bar{Q} \text{ or } Q_{\text{med}} = C A^a R^b S^c \dots \dots \dots [2 \text{ marks}]$$

- (c) A catchment has a 1 cm 1 hour unit hydrograph whose time to peak is 5 hours. Determine the design storm, according to the FSR/FEH method, for use with the UH to determine the 25 year return period flood. The following values apply:

2 day R_5	=	60 mm	
r	=	0.21	
\bar{R}	=	1200 mm /yr	
% Runoff	=	50%	
Catchment area	=	300 km ²	[6 marks]

Indicate how to obtain the first three (only) ordinates of the storm profile.
[1.5 marks]

6. (a) What is understood by Regional Homogeneity in regional flood frequency analysis. In current practice what procedure is used in order to achieve it.
[4 marks]
- (b) A pooling group of 3 stations has the following annual maximum flood series statistics, where M_{1j0} means a probability weighted moment.

Station	Record Length	M_{100}	M_{110}	M_{120}
1	40.0	350.3	191.1	133.4
2	35.0	204.0	121.2	88.2
3	45.0	87.9	48.3	33.6

From this calculate the growth curve ordinates for return periods 2, 10, 25, and 50 years using the GLO distribution and display these values on an appropriate plot.
[8 marks]