

**OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY**

Semester II Examinations 2005

M. Appl. Sc. Examination

EH 514 – Applied Hydrology V

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

Time Allowed: Three hours.
Attempt five questions.

1. (a) Explain what is meant by single event and continuous simulation rainfall runoff models and give examples. *[4 marks]*

Distinguish between lumped and distributed models and between conceptual and physically based models. *[4 marks]*
- (b) Show, with the help of a diagram, the principal elements in any rainfall runoff model of your choice. *[8 marks]*
- (c) Explain the role played by the Principle of Least Squares in hydrological modelling. *[4 marks]*
2. (a) Show how the continuity equation for a lake is re-arranged for the purposes of determining an outflow hydrograph corresponding to a given inflow hydrograph. *[4 marks]*
- (b) A lake of surface area, 3km^2 outflows through an 8 m long Crump weir whose crest is at 50 m O.D.
The first 4 ordinates of an observed outflow hydrograph are

Time, hrs	0	6	12	18
Q, m^3/s	2	9	26	55

- (i) Determine the corresponding inflow ordinates. *[6 marks]*
- (ii) Determine the outflow resulting from these calculated inflows if the outflow weir is reduced from 8 m to 5 m long. *[10 marks]*

3. (a) Explain what is meant by the following terms:

- Coefficient of Variation, C_v
- Coefficient of Skewness, g .
- L- C_v
- L-Skewness.

[4 marks]

What advantage does the L-Skewness coefficient have over the coefficient of skewness g ?

Indicate typical ranges of values for C_v and g for annual maximum flow series in Irish rivers.

[4 marks]

- (b) The annual maximum floods of a particular Irish river have the following statistics:

$$\begin{array}{lll} \text{mean} = 149 \text{ m}^3/\text{s}, & C_v = 28\%, & g = 1.01 \\ Q_{\text{med}} = 148 \text{ m}^3/\text{s}, & M_{110} = 86.00, & M_{120} = 61.61 \end{array}$$

Estimate the 100 year return period flood for this location by each of the following methods.

- EV1 distribution
- Pearson Type 3 distribution
- GLO distribution

[9 marks]

- (c) Obtain an approximate value for the standard error of estimate of Q_{100} if the record length is 60 years. What practical use would you make of this figure in an engineering design context?

[3 marks]

4. (a) Explain, with the help of a diagram, what is involved in the Index Flood Method of flood quantile estimation.

[4 marks]

- (b) How would you expect the flood growth curves for Ireland, SE England and any tropical country to differ from one another? Use a diagram to illustrate your answer. Does the region with the largest growth factor actually have the largest flood per square kilometre?

[4 marks]

- (c) What is understood by the term regional homogeneity as applied to regional flood frequency growth curves? How is homogeneity achieved in the UK FEH methodology?

[6 marks]

- (d) Equations of the type \bar{Q} or $Q_{\text{med}} = c A^a R^r S^s \dots$ are used for flood estimation. Explain

- (i) how the variables on the right hand side are selected
- (ii) how the coefficients $c, a, r, s \dots$ are obtained
- (iii) the usefulness/validity/limitations of such formulae.

[6 marks]

5. (a) Explain what is meant by the S-curve in hydrological analysis. If a catchment has an area of 80 km^2 what is the value of the final steady state S-curve value if rainfall is measured in cm? *[5 marks]*

- (b) The ordinates of a 1 cm 1 hour UH at 1 hour intervals are:

0 62 25 48 21 12 40

Using the 30 min 1 cm UH, determine the net runoff hydrograph from a storm, specified at 30 minute intervals, as follows in cm,

1.5 3.0 6.0 2.0

Assuming that the percentage runoff values for successive intervals are 40%, 45%, 50% and 55%. *[15 marks]*

6. (a) A sequence of annual minimum flows is as follows, m^3/s ,

2.2 2.9 3.3 3.5 4.0 8.0

- (i) Show these on a suitable probability plot type of graph and show clearly how the return period scale is determined. *[6 marks]*
 - (ii) In Ireland the EV1 distribution is sometimes a good descriptor of annual minimum flows. Comment on this in light of the fact that EV1 is a distribution of maxima. *[2 marks]*
 - (iii) Frequency analysis of annual values of q_{95} from flow duration curves is sometimes carried out. What is the motivation for using q_{95} and in what type of application is it encountered. *[2 marks]*
- (b) (i) In rainfall frequency analysis what does the term areal reduction factor represent and why it is needed? *[2 marks]*
- (ii) Determine the rainfall intensity duration relationship for return period 10 years for $D = 1, 3$ and 6 hours for a location in Ireland which has 2 day $R_5 = 55 \text{ mm}$ and $r = 60 \text{ min}$ $R_5/2 \text{ day } R_5 = 0.21$. *[5 marks]*
- (iii) A rural catchment has time to peak of the one hour 1 cm unit hydrograph, $t_p = 12$ hours. Determine the gross rainfall depth of a design storm for use in the FSR design flood method for a flood return period of 50 years. Take annual average rainfall for the location to be 1200 mm. *[3 marks]*

7. (a) Explain the role of interception in the hydrological cycle. Comment particularly on the effect of afforestation on floods and on water resources. *[4 marks]*

- (b) In the context of soil moisture explain the following
- Soil water tension
 - Field capacity
 - Soil water characteristic
 - Bubbling pressure.

If $pF = 2$ at field capacity what is the corresponding tension head? Show how the answer is obtained. *[5 marks]*

- (c) If air temperature is 14°C and relative humidity is 68% what is the corresponding wet bulb temperature? *[3 marks]*
- (d) In Penman's expression for outgoing longwave radiation from the surface of the earth explain the relevance and effect of each component. *[3 marks]*
- (e) Compare the Penman equation for open water evaporation with the Penman Monteith equation for evapo-transpiration, pointing out the similarities and differences. In particular explain the role of the resistance term and the analogy with Ohm's Law. *[5 marks]*