OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

Semester I Examinations 2002

B.E. Degree – Civil Engineering/Environmental Engineering

EH 406 – Engineering Hydrology I

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

Time Allowed: Two hours.

Attempt four questions.

1. (a) Explain what is understood by the terms *Sustainability* and *Integrated River Basin Management (IRBM).* *[4 marks]*

(b) Distinguish between the practice of Supply Management and Demand Management in the practice of *IRBM.* *[4 marks]*

(c) Explain in broad terms the options available to society in relation to coping with river flooding. How can or should these be taken into account in planning policy in relation to land use zoning? *[4.5 marks]*

2. (a) A lake has surface area $A(H) = 2.0 + 0.175\ (H - Ho)\ km^2$ where H = water elevation in m OD. Ho = 75.0m OD is the elevation of the crest of a Crump weir which controls the lake outflow. The weir coefficient of a Crump weir is 1.96. The weir crest length, transverse to the direction of flow, is 6m.

(i) Calculate the lake storage volume above Ho and lake discharge for water levels H = 75.0, 75.5, 76.0 and 76.5.5 and display these on a graph of S versus Q. *[4 marks]*

(ii) Determine a value for the storage parameter K when $Q = 10m^3/s$. *[2 marks]*

(iii) A series of inflows to the lake were measured as follows:

Time (hours)	0	2	4	6
Inflow (m^3/s)	3	14	10	7

If the outflow at time t = 2 hours is $4m^3/s$ determine the outflow (discharge) and water levels at times t = 4 and t = 6 hours *[6.5 marks]*

3. (a) A small sample of annual maximum flood values, all in m^3/s, is as follows:

80, 95, 120, 160, 105

(i) Calculate the probability weighted moments (PWMs) M_{100} and M_{110} for this sample. *[4 marks]*

(ii) Hence, using these PWM values, calculate the parameters u and α of the corresponding EV1 distribution and the 10 year return period flood magnitude in this distribution. *[2 marks]*

(b). Display the above data on a n EV1 style probability plot, on an EV1 base, and show on the plot a scale for return period T. Show also on the plot the line corresponding to the distribution identified in (a)(ii) above. *[6.5 marks]*

4. (a) The following quick response or net runoff ordinates resulted from gross rainfalls of 4 cm and 0.5 cm over successive two hour periods on an 18 km^2 catchment.

Time t (hrs)	0	2	4	6	8	10	12	14	16	18
Q (m^3/s)	0	2.2	8.4	14.9	10.3	5.9	3.6	1.9	0.7	0.0

(i) Calculate the percentage runoff and the net rainfall depth. *[4 marks]*

(ii) Assuming that all of the net rainfall occurred during the first 2 hour period calculate the ordinates of the 1cm 2hour unit hydrograph. *[4 marks]*

(iii) Hence find the peak runoff from a 2 hour storm during which 7 cm of gross rainfall occurred if the percentage runoff was 65%. *[2 marks]*

(b) If a unit hydrograph, such as that calculated in (a)(ii) above, were to be represented by a triangular shape what conditions would the triangle have to satisfy for it to act as a satisfactory substitute for the original UH? *[2.5 marks]*

5. (a) (i) Explain the term storativity as applied to aquifers and explain why its value differs significantly between confined and unconfined aquifers.

If a local perched unconfined aquifer has areal extent of 20 ha and a specific yield value of $S_y = 0.35$ how much water needs to be extracted from it in order for its water table to be lowered by 0.75m? *(1ha = 10000m²)* *[4 marks]*

(ii) The land surface area above a horizontal confined aquifer of uniform thickness 50m was observed to have subsided by 0.14m over a period of years owing to the extraction of groundwater. If the compressibility of the aquifer skeletal material is $\alpha = 1.6 \times 10^{-8}$ m²/N by how much was the potentiometric surface reduced over the period of pumping? *[3 marks]*

(b) Starting with the Theis solution for drawdown in a confined aquifer due to pumping and the approximation $W(u) = -0.5772 - \ln(u)$, $u < 0.01$, for the well function demonstrate that drawdown is a linear function of $\log(t)$ where t is time since commencement of pumping.

Hence show that the Cooper-Jacob time drawdown equations for the aquifer parameters T and S are

$$T = \frac{2.30Q}{4\pi\Delta s} \quad \text{and} \quad S = \frac{2.25Tt_0}{r^2} \qquad \textit{[5.5 marks]}$$

6. (a) How much energy is required to evaporate a layer of 4 mm water from a surface area of 9 ha when the ambient temperature is 15°C. (1ha = 10000m²). *[2 marks]*

(b) According to Penman's energy equations what percentage of incoming radiant energy from the sun reaches the earth's surface

(i) on a cloud-free day

(ii) on an entirely cloudy day? *[4 marks]*

(c) Determine daily evaporation by the Dalton aerodynamic method, as calibrated by Penman, for a location where air temperature = 14°C, wind speed = 6 m/s and vapour pressure = 1.05 kPa. *[4.5 marks]*

(d) Explain what the resistance terms in the Penman-Monteith equation for evaporation represents. *[2 marks]*