UNIVERSITY OF WEST ATTICA
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

MSc by Research in Electrical and Electronics Engineering
Indicative test exam in the course: MRES.B.02.07- Small Hydro-electric power plant
Duration**: 15 minutes** Athens, ….
Surname: ..... Name: .....
Register number:**.....**

Issue 1

A steel tube of nominal diameter DN800 with an external diameter of 812.8 mm, wall thickness of 7.1 mm, internal roughness of 1 mm is used as a penstock of a small hydro-electric plant having a nominal water flow of 1.6 m^3/s. The penstock length L is 1.5 km. The friction factor λ is given by Colebrook-White equation iteratively: $\frac{1}{\sqrt{\lambda}} = -2 \cdot \log\left[\frac{2,51}{\mathrm{Re} \cdot \sqrt{\lambda}} + \frac{\varepsilon}{3,71 \cdot d}\right]$

where ε is roughness, d the internal diameter, Re Reynolds number given by:

$$\mathrm{Re} = \frac{u \cdot d}{v}$$

where v is the water kinematic viscosity ($=10^{-6} m^2/s$ for 20°C), u the water velocity.
The linear hydraulic head losses are given by:

$$\delta h_{fEe} = \lambda \cdot \frac{L}{d} \cdot \frac{u^2}{2 \cdot g}$$

Where g is the gravity acceleration (= 9.81 m^2/s).
The local hydraulic head losses are given by:

$$\delta h_f = \sum \zeta \cdot \frac{u^2}{2 \cdot g}$$

Where ζ is the local resistance of each element (0.5 for valve, 0.05 for curves). In this case the penstock has 4 valves and 12 curves.
The available hydraulic head is 400 m.
(a) Calculate the water speed in the tube in m/s. Is the respective value acceptable (the maximum water speed in steel tube is equal to 4 m/s)? (1.5 marks)
(b) Calculate the linear hydraulic head losses in m, where 3 iterations should be carried out for the calculation of λ, at least. The initial value of λ is equal to 0.020. (4 marks)
(c) Calculate the local hydraulic head losses in m, (1.5 marks)
(d) Calculate the total hydraulic losses of the tube in m. Is the respective value acceptable with respect to the with respect to the available hydraulic head (in this case the maximum limit is 5%)? (1 mark)

Issue 2

Which are the basic parts of a small hydro-electric power plant (SHPS)? Give a proper simplified figure of a SHPS. (2.0 marks)