

**Exercise 02 – Fans and Pumps**

(\* For self-evaluation, no need to submit. Solution outlines will be provided later.)

1. What are the important design considerations for chilled water systems? Briefly explain the principles for analysis of pipe network in a water distribution system.
2. Draw a diagram to show typical design of a variable flow chilled water system with plant-building loop. Explain the pump affinity laws that can be used to evaluate pump performance and characteristics. What precaution shall be taken to minimise the risk of cavitation at the pump impeller?
3. Briefly describe the five common methods for fan modulation and capacity control. With the help of suitable diagrams, explain the likely unstable regions for centrifugal and axial fans.
4. Briefly explain the five major issues causing energy losses to a centrifugal fan. Draw a simple diagram of fan pressure against flow rate to show how the actual fan performance curve is obtained by deducting the energy losses from the theoretical line.
5. Using the Darcy-Weisbach equation and other related formulae, calculate the frictional loss for 2 m long of an air duct with  $D = 0.2$  m, surface roughness  $\varepsilon = 0.003$  m, mean air velocity inside the air duct  $v = 5$  m/s. Assume air density  $\rho = 1.2$  kg/m<sup>3</sup>, absolute viscosity  $\mu = 0.00002$  Pa·s and gravitational constant  $g = 9.81$  m/s<sup>2</sup>. The frictional factor may be determined using the following empirical equation.

$$f = \frac{0.25}{\left\{ \log \left[ \frac{\varepsilon}{3.7D} + \frac{5.74}{0.9 \text{Re}_D} \right] \right\}^2}$$