UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2018

Module Number: ME8302 Module Name: Industrial Fluid Dynamics

[Three Hours]

[Answer **all questions,** each question carries **twelve marks]**

Q1. (a) Explain the situations where local losses are important in estimating in pipe networks.

[2 Marks]

(b) "Resistance to flow in non-circular conduits is more difficult to estimate than that in circular conduits" Explain the statement giving reasons.

[2 Marks]

(c) Write the equations for Lift Coefficient, Flow Coefficient and Power Coefficient used for model testing of centrifugal pumps.

[2 Marks]

(d) The performance of a large centrifugal pump with an impeller diameter of 80 cm is to be predicated at a laboratory using a similar centrifugal pump with an impeller diameter of 10 cm. The model was tested with a capacity of 0.01 cm^3/s at 1000 rpm against a total head of 8 m. The power consumed by the model was found to be 26 kW. If the prototype pump has to work against a head of 26 m, calculate the following for the prototype pump assuming no difference in efficiencies,

(i) The working speed of the pump

(ii) The power required to drive it

(iii) The flow capacity.

[6 Marks]

Q2. (a) What are the advantages of a properly designed air conditioning ducting system in a building?

[2 Marks]

Q2 is continued on page 2..

(b) Discuss a suitable design method for air conditioning ducting system in a cruise ship.

[2 Marks]

(c) In a restaurant, accommodation of air conditioning duct size is restricted to 2:1 by a low ceiling height. Figure Q2(ci) shows the schematic of a typical supply air duct lay out plan proposed for the restaurant. The air flow rate requirement for each branch is also indicated in the figure. The length of main and branches of the ducts are given in Table Q2(c). If the duct material is galvanized steel, using the equal-friction method, determine the following,

(i) Frictional losses in ducts

(ii) Fan total pressure

(iii) Power required to supply air

(iv) Total sheet metal area required for the duct system.

Note: Take the velocity of air in the main duct as 8 m/s, a dynamic loss coefficient of 0.3 for upstream to down stream and 0.7 for upstream to branches and for elbows. The exit loss coefficient for the outlet is taken as 1.0. Figure Q2(cii) shows the circular equivalents of rectangular duct.

[8 Marks]

Q3. (a) Explain differences in two-phase flow pattern in vertical and horizontal orientation tubes.

[2 Marks]

(b) How do you select the two-phase frictional pressure drop models with respect to two-phase flow patterns?

[2 Marks]

(c) Gasoline is transported in a smooth horizontal tube of 20 cm diameter. When the tube is exposed to Sunlight, a part of the gasoline is evaporated and mixture of liquid gasoline and vapor flow inside the tube. The mass flux of the mixture is 900 kg/m^{3}s and the mass quality is 0.055. The physical properties of the individual phases are ρ_G= 1.19 kg/m^3, ρ_L=720 kg/m^3, μ_G=1.7x10^{-5} Pas and μ_L= 6.0x10^{-4} Pas. Determine:

(i) The single-phase pressure gradients

(ii) The Lockhart and Martinelli parameter (*X*)

Q3(c) is continued on page3..

(iii) The pressure drop across the 20 km with only liquid phase

(iv) The pressure drop across the same distance in Q3(iii) with two-phase flow using Chisholm C coefficient method.

[8 Marks]

Q4. (a) Describe briefly the components of a Francis Turbine.

[2 Marks]

(b) What do you understand by the degree of reaction of a turbine?

[2 Marks]

(c) A Francis turbine has a runner of 60 cm diameter and the width at the inlet is 6 cm. The inner diameter is 46 cm and the width at the outlet is 9 cm. The vanes occupy 5% of the peripheral area. The guide vane angle at the inlet is 22°and the blade angles at the inlet and outlet are 80° and 25°, respectively. The head on the turbine is 65 m and the hydraulic efficiency is known to be 90%. Assuming a mechanical efficiency of 95%, calculate,

(i) The velocity of flow

(ii) The head extracted

(iii) The discharge

(iv) Power delivered by the turbine.

[8 Marks]

Q5. (a) Write short notes on following,

(i) Double suction centrifugal pump

(ii) Booster pump.

[2 Marks]

(b) What is the function of the following in a centrifugal pump?

(i) Foot valve

(ii) Volute casing

(iii) Delivery valve.

[2 Marks]

(c) A centrifugal pump lifts water from a sump to an overhead reservoir. The static lift is 50 m out of which 4 m is the suction lift. The suction and delivery pipes are both 30 cm diameter. The friction loss in the suction pipe is 2.0 m

Q5(c) is continued on page4..

and in the delivery pipe it is 6.0 m. The impeller is 0.5 m in diameter and has a width of 3.5 cm at the outlet. The speed of the pump is 1200 rpm. The exit blade angle is 20°. If the manometer efficiency is 85%, determine,

(i) The pressure at the suction and delivery ends of the pump

(ii) The discharge of the pump.

[8 Marks]

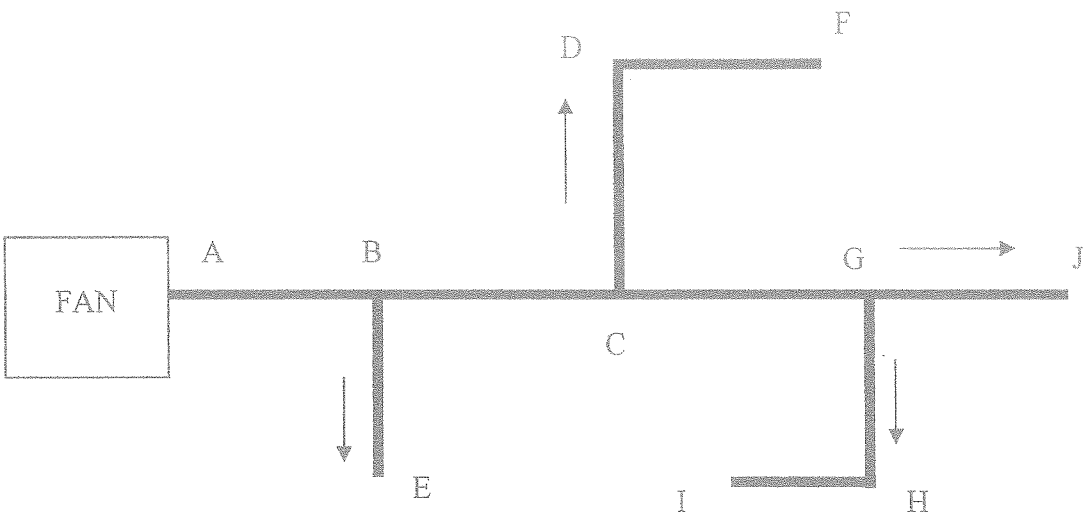

Figure Q2(ci)

Duct	Length (m)	Flow rates (m^3/s)
AB	06	
BE	10	0.75
BC	05	
CD	05	0.9
DF	04	
CG	10	
GH	06	0.9
HI	04	
GJ	05	1.0

Table Q2(c)

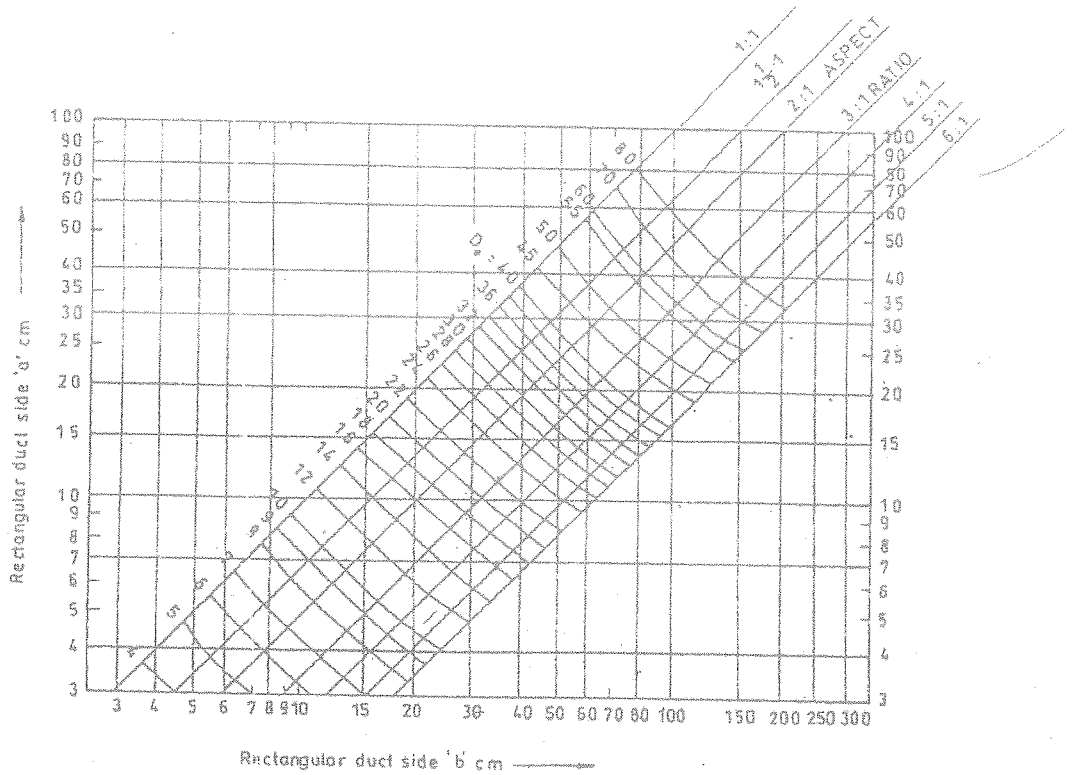

Figure Q2(cii)