UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	DAK 10703
PROGRAMME	:	2 DAK
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Define the pressure head, velocity head, and elevation head for a fluid stream and express their equation for a fluid stream whose pressure is P, velocity is V, and elevation is z.

(6 marks)

(b) Illustrate the necessary width, length or diameter for a cylindrical column and rectangular column which is filled with 10kg of water resulting in a water depth of 50cm in the column ($\rho = 1000 \text{ kg/m}^3$). Use conservation of mass principle.

(8 marks)

(c) Explain what is macro problems and micro problems related to pipe flow with the aid of suitable diagram.

(8 marks)

(d) Outline any three (3) physical similarities of venturi meter and orifice meter based on your activities in fluid mechanics laboratory.

(3 marks)

Q2 (a) Predict the parameter that can be measured associated with the statements below with their SI unit

(i) A Ferrari car is almost two times faster than a normal road car.

(ii) Malaysian is among a county with high obesity people.

(iii) Perodua Axia boot volume size is larger than Perodua Myvi.

(iv) A balloon can explode if its pressed too hard.

(v) A cup of hot chocolate is delicious to drink while its still warm.

(10 marks)

(b) Explain the theory behind the hydrostatic pressure test based on its equipment sketching and its simplified experimental procedure.

(10 marks)

(c) Discuss the significance of Reynolds number in determining flow regimes in the pipeline.

(5 marks)

Q3 (a) Define conservation of mass, conservation of energy and conservation of momentum and express equations associated with them.

(6 marks)

(b) (i) Give three (3) examples of flow measurement devices associated with the conservation of energy, encountered in fluid mechanics laboratory activities.

(3 marks)

(ii) Illustrate a diagram on each device mentioned in **Q3 (b)(i).**

(6 marks)

(c) Air enter a compressor with a velocity of 5 m/s through a 2 cm × 2 cm square inlet duct. Air is then discharged from the compressor with a mean velocity of v_2 m/s in a 0.04 m diameter circular pipe. Determine the mass flow rate and the density at the outlet pipe (air density = 1.2 kg/m^3).

(i) Illustrate a diagram for dimensions of the inlet and outlet section.

(ii) Calculate the outlet mass flow rate using $\rho_1 A_1 v_1 = \rho_2 A_2 v_2$.

(iii) Calculate the density of air at outlet pipe, using similar mass flow rate in (ii) if the actual outlet velocity, v_2 is 1.8m/s.

(10 marks)

Q4 (a) Discuss the three flow regimes in pipe flow studied by Osborne Reynolds.

(6 marks)

(b) A steel pipe with inner diameter 2.5cm is pumped with oil (ρ = 860 kg/m^3 and viscosity μ = 0.0103 kg/ms). Solve the velocities required for the oil flow to be laminar, transitional and turbulent.

(6 marks)

(c) A student is designing a piping system to pump water from a well (telaga) into a tank, situated 15m higher. The designed pumping rate is 6 L/min. The pipeline length is 50 meter and 25mm in diameter. The pipeline is equipped with **ten** 90° elbows, **two** standard T and **five** 45° elbow. Solve the required pump power for this operation.

[ρ = 1000 kg/m^3 , $\mu = 1 \times 10^{-5}$ Ns/m^2, 1m^3 = 1000L, η = 85%]

(13 marks)

Q5 (a) (i) Define drag force, Fd experienced by any moving object.

(3 marks)

(ii) Explain why coefficient of drag, Cd for a lorry (Cd = 0.99) is higher than a normal road car (Cd = 0.35).

(4 marks)

(b) A man jump in a parachute downwards with the velocity of 5m/s do. The net weight of parachute and the man is 100kg. With proper sketching, determine the diameter of the open parachute ($g = 9.81\ ms^{-2}$, Cd = 1.39).

(6 marks)

(c) Air flows along a flat, square plate of 2m long and 2m wide at a velocity of 3 ms^{-1} ($\rho = 1.2\ kg/m^3$, $\mu = 0.00002$ kg/ms).

(i) Determine the drag force on this plate based on its flow regime.

(ii) Determine the drag force if the plate was mounted perpendicularly to the flow direction, asssuming Cd = 1.4 and the velocity of air increase to 5 ms^{-1}.

(iii) Sketch a diagram to visualize direction of air flow and plat position for each case of (i) and (ii).

[For laminar flow, $Cd = 1.328 / Re^{0.5}$ and $Re < 5 \times 10^5$]

(12 marks)

Q6 (a) Summarize the derivation of momentum balance equation on x and y axis when water jet with frontal diameter A and velocity V_1 strikes a stationary flat plane at angle θ as shown in **Figure Q6** with the aid of suitable diagram (assume $V_1 = kV_2$ and k = 1 in this case).

(8 marks)

(b) Air initially flows over a sharp edged flat plate which is 4m long and 3m wide at a velocity of 2m/s, and then reached 4m/s. Solve for both boundary layer thicknesses, δ due to these air flow speeds ($\rho = 1.2\ kg/m^3$, $\mu = 0.0002$ kg/ms).

(6 marks)

(c) Explain *plane couette flow* theory with the aid of necessary diagram.

(6 marks)

(d) Produce two diagrams to visualize all forces acting on a man riding on a parachute and forces acting on a free falling sphere.

(5 marks)

- END OF QUESTION -

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Formula

$V = m \div \rho$, where V is volume

$V_{cylinder} = \pi (D^2/4) \times H$ where $\pi = 3.142$

$V_{rectangle} = W \times L \times H$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

$Re = \rho D v \div \mu$ or $(Re = \rho L v \div \mu)$, where μ is dynamic viscosity

$g = 9.81 \text{ m/s}^2$

90° elbows, K = 0.9

standard T, K = 1.8

45° elbow, K = 0.42

$h_{total} = h_f + h_o + h_z$

$h_f = 4fL \div D \times (v^2 \div 2g)$

$h_o = K \times (v^2 \div 2g)$

$h_z = z$ (meter)

$f = 16 / Re$ (laminar, Re < 2000)

$f = 0.079 \div Re^{0.25}$ (turbulent, Re > 4000)

Pump Power $= \rho\, g\, Q\, h_{total} \div \eta$

$Fd = 0.5\, \rho\, v^2\, A\, Cd$, where v is velocity

$Cd = 1.328 / Re^{0.5}$ (laminar, $Re < 5 \times 10^5$)

$Fg = m \times g$

$\delta = 5L / Re^{0.5}$ (laminar, $Re < 5 \times 10^5$)

$\delta = 0.38L / Re^{0.2}$ (turbulent, $Re > 5 \times 10^5$)

$\Sigma F = Fd - Fg - F_B = 0$