ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF

MECHANICAL, AUTOMOTIVE AND PRODUCTION ENGINEERING

FIRST SEMESTER EXAMINATIONS

2017/2018 ACADEMIC SESSION

COURSE: MEE 307 – Applied Fluid Mechanics I (2 Units)

CLASS: 300 Level Mech. & Automotive Engineering

TIME ALLOWED: 2 Hours

INSTRUCTIONS: Answer any **FOUR** questions

HOD'S SIGNATURE

Date: March, 2018

Question 1

1 (a) Define the following terms/ State the following Laws as applicable:
(i) Absolute Pressure (ii) Vapour Pressure (iii) Fluid Static Law
(iv) Pascal's Law (v) Archimedes Principle

(b) (i) In a fluid, the velocity measured at a distance of 75mm from the boundary is 1.125 m/s. The fluid has absolute viscosity of 0.048 Pa s and relative density of 0.913. What is the velocity gradient and shear stress at the boundary assuming a linear velocity distribution? Determine its kinematic viscosity.

(ii) An empty balloon and its equipment weighs 50kg, is inflated to a diameter of 6m, with a gas of density 0.6kg/m^3. What is the maximum weight of cargo that can be lifted on this balloon, if the air density is assumed constant at 1.2 kg/m^3? (Take g =9.81ms^{-2})

(c) A bend in a horizontal pipeline reduces from diameters 600 mm to 300 mm whilst being deflected through 60^0. If the pressure at the larger section is 300kPa, for a water flow rate of 800l/s, determine the magnitude and direction of the resultant force on the pipe. (Take ρ_{water} = 1000kg/m^3, g =9.81ms^{-2}). (Hint: x-momentum [$-F_x + P_1A_1 - P_2A_2\cos\Theta = \rho Q(V_2\cos\Theta - V_1)$], y-momentum [$-F_y + P_2A_2\sin\Theta = \rho Q(-V_2\sin\Theta - 0)$])

[15 marks]

Question 2

2(a) Explain the viscosity of liquid and describe its dependence on temperature with a suitable example. What is a Pressure Transducer? Differentiate between Newtonian and Non-Newtonian Fluids with examples

(b) (i) A jet of water of 50mm in diameter exits a nozzle directed vertically upwards at a velocity of 10m/s. Assuming the jet retains a circular cross section, determine the diameter (m) of the jet at a point 6.5m above the nozzle exit. Take $\rho_{water} = 1000 kg/m^3$.

(ii) A flat circular plate, 1.25m diameter is immersed in water such that its greatest and least depths are 1.5m and 0.6m respectively. Determine the force exerted on one face by the water pressure. Also, find the position of the centre of the pressure. (Second Moment of Area, $I_c = \pi R^4/4$)

[15 marks]

Question 3

3(a) (i) Differentiate between an impulse turbine and a reaction turbine with the aid of simple sketches and an example of each.

(ii) Diesel fuel is to be pumped between two storage tanks using 800m long pipe with 5cm inner diameter at a rate of 10 tonne/hr. The overall vertical difference between the liquid levels of the two tanks is 15m. The tanks are open to atmosphere through vents. Let the specific gravity of the diesel fuel be 1.3, and the viscosity is 0.001 Pa s. In the pipework, there is a globe valve (fully open, equivalent to 150 pipe diameters) and five 90^0 standard radius bends (30 pipe diameters each). The relative roughness of the pipe is 0.002. Any other losses can be considered negligible. Using figure 1, what power requirement of the centrifugal pump is used if the efficiency of the pump is 75%

(b) Consider a fluid with density $600 kg/m^3$ placed in a 5mm gap between two parallel plates. The top plate is moved with a constant velocity of $0.25 ms^{-1}$ over the fixed bottom plate. The top plate experiences a shear stress of $0.125 Nm^{-2}$. Determine the kinematic viscosity of the fluid. If the same fluid is flowing through a pipe diameter of 300mm and a pitot tube with an external manometer is connected to the pipe, calculate the volumetric flowrate in the pipe together with the Reynolds number of the pipe flow. Take the height difference between the manometric fluid which is water between the two legs to be 33mm. (Take g $=9.81 ms^{-2}$). (Hint: $V_1 = \sqrt{[2hg(\frac{\rho_w}{\rho} - 1)]}$)

[15 marks]

Question 4

4(a) A venturi meter fitted in a 12cm pipeline has a throat diameter of 6cm. The pipe carries water, and a u-tube manometer mounted across the venture has a reading of 75mm of mercury. Determine the pressure drop in pascal's indicated by the manometer, the ideal throat velocity (m/s) and the actual float rate (l/s) if the meter C_d is 0.9. (Take $\rho_{mercury}$ = 13600kg/m^3, ρ_{water} = 1000kg/m^3, g =9.81ms^{-2})

(b) State the Buckingham's pi theorem and use this theorem to derive the pressure drop in a pipe to obtain the functional relationship of the Darcy-Weisbach equation

$$\frac{\Delta P}{\rho v^2} = f\left(\frac{\mu}{\rho v D}, \frac{L}{D}, \frac{e}{D}\right) = f\left(\frac{1}{Re}, \frac{L}{D}, \frac{e}{D}\right)$$

[15 marks]

Question 5

5(a) With the aid of simple sketches and examples where applicable, explain the following terms.
(i) Normal Shock Waves (ii) Oblique shock waves (iii) Expansion waves
(iv) propagation of sound waves from a moving source with supersonic flow
(v) propagation of sound waves from a moving source with subsonic flow

(b) An electronic device is situated on the top of a hill and hears a supersonic projectile that produces Mach waves after the projectile is 500 m past the device's position. If it is known that the projectile flies at 850 m/s in air of temperature of 22^{0}C, estimate how high it is above the device.

(c) Air flows from a reservoir maintained at 300 kPa absolute and 20°C into a receiver maintained at 200 kPa absolute by passing through a converging nozzle with an exit diameter of 4 cm. Calculate the mass flux through the nozzle.

[15 marks]

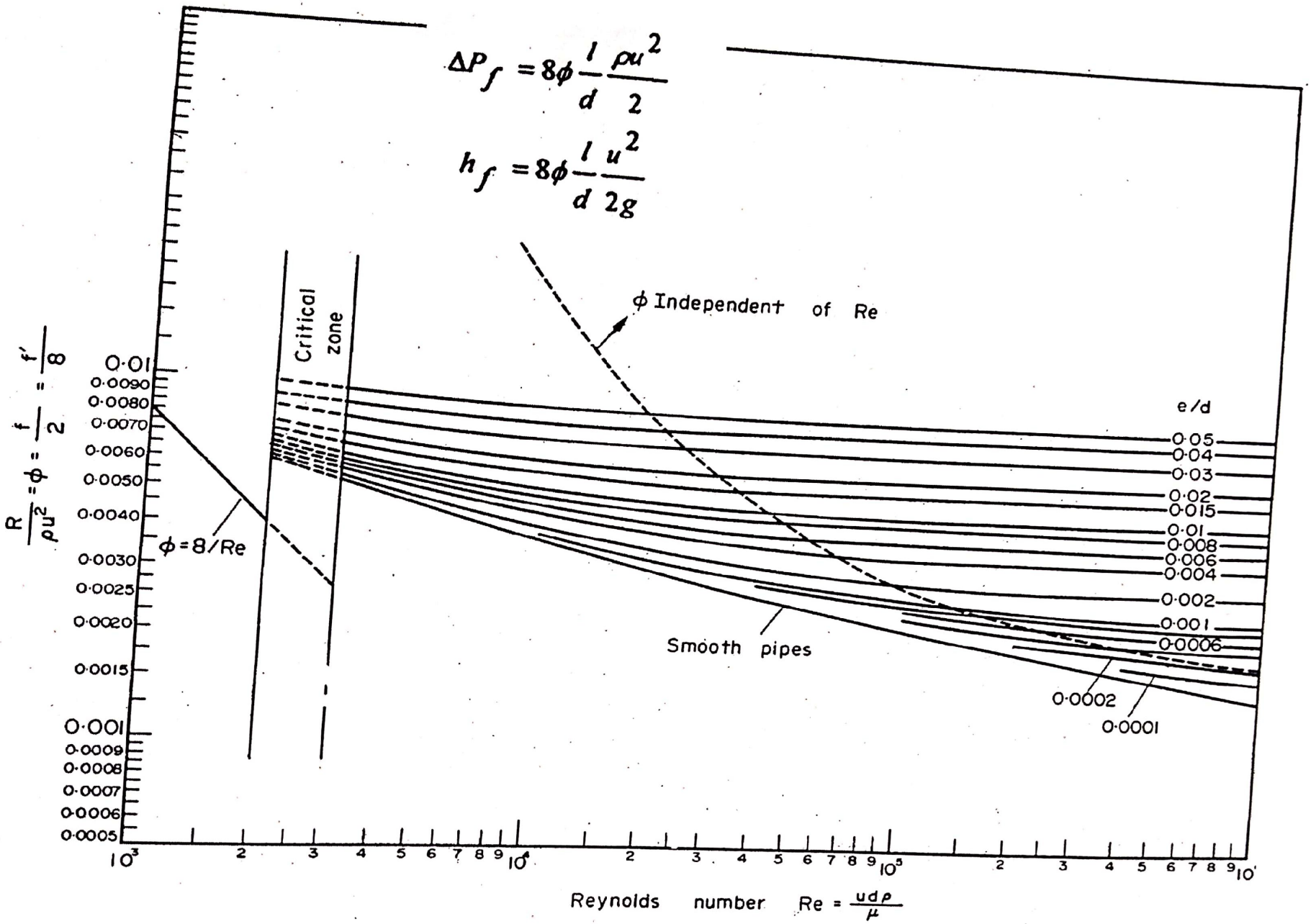

Figure 1: Moody Diagram