W1-2-60-1-6

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
UNIVERSITY EXAMINATIONS 2017/2018

THIRD YEAR FIRST SEMESTER EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2301: FLUID MECHANICS II

DATE: JANUARY 2018 TIME: 2 HOURS

INSTRUCTIONS

i) This paper contains FIVE questions

ii) Each question carries 20 marks

iii) Attempt any THREE questions

Q1 (a) (i) Differentiate between vicious and non-viscous flows. (2 marks)

(ii) Assisted by diagrams, describe the Reynolds experiment and discuss the observations. (6 marks)

(b) (i) In fluid flow through pipes, state the meaning of the terms; critical velocity and critical Reynolds number. (2 marks)

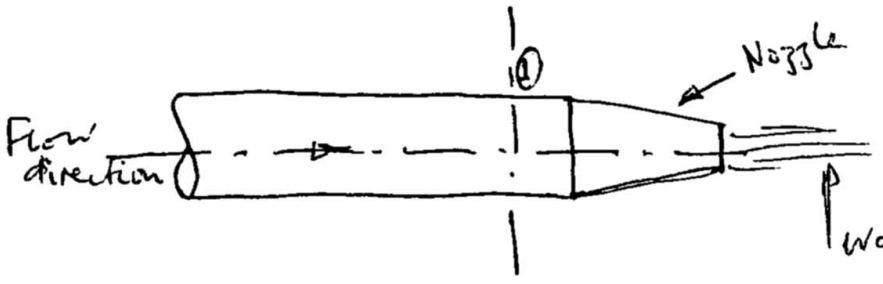
(ii) Derive an expression for a force exerted by water on a 135^0 bend i.e. change from initial to final direction is 135^0. (6 marks)

(c) 300 liters/second of water flows through a pipe of diameter 40cm. if the pipe is bend by 135^0, (i.e. change from initial to final direction is 135^0), calculate the magnitude and direction of the resultant force on the bend. The pressure of water flowing is $40 \times 10^4 N/m^2$. (4 marks).

Q2 (a) (i) Define the terms; impact of jets and jet propulsion. (2 marks)

(ii) Explain how a Rocket is propelled forward on the outer space and derive an expression for a force at a nozzle ejecting a water jet. (6 marks)

(b) A water jet issues from a 30mm diameter fire hose at the end of which a 10mm diameter nozzle is fixed. If the pressure at section (1) in the figure below is 300 Kn/m^2 gauge, calculate the force exerted by the nozzle on the water jet. (6 marks)

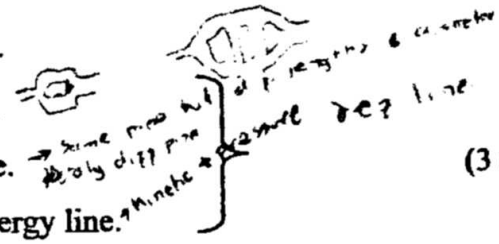


(c) Derive the moment of momentum equation and mention two situations where the equation can be applied (6 marks)

Q3 (a) (i) Differentiate between the following:-

- Pipes in parallel and pipes in series.
- Compound pipe and equivalent pipe.
- Hydraulic gradient line and total energy line.

(3 marks)



(ii) State how to calculate the pressure head loss when pipes are in series and when they are in parallel arrangements. $Q_1 = Q_2$ (2 marks)

(b) (i) State why nozzles are fitted at the end of pipes and give two practical examples where nozzles are used. (3 marks)

(ii) Obtain an expression for the power transmission through pipes and derive the condition for the maximum power transmission through pipes. $P = \rho Q(H - H_2)$ $h_p = 337.855\, H_p$ (6 marks)

(c) A pipe of diameter 20cm and length 3000m is used for the water power transmission. The total head at the inlet of the pipe is 450m. Calculate the maximum power available at the outlet of the pipe (given friction factor "f" = 0.007). (6 marks)

Q4 (a) (i) For flow in an open channel, differentiate between the following:-

- Uniform and non-uniform flows
- Steady and unsteady flows
- Critical, sub-critical and super-critical flows

(4 marks)

(ii) Assisted by diagrams, state the meaning of the following terms;

- Rapidly varied flow
- Gradually varied flow
- Affux
- Back water curve

(2 marks)

(b) (i) State what is meant by "the most economical section of a channel" and derive the conditions for the most economical rectangular channel. (5 marks)

(ii) Obtain an expression for the discharge through a channel by Chezy's formula. (4 marks)

(c) Water flows at 160 liters per second down a rectangular channel of width 80cm and having adjustable bottom slope. If Chezzy's constant is 70, calculate the bottom slope necessary for uniform flow with a flow depth of 30cm. (5 marks)

Q5 (a) (i) Define the term "dimensional analysis" and state what is meant by the expression "dimensionally homogeneous equation". (2 marks)

(ii) Mention TWO methods used in dimensional analysis and describe anyone of them. (4 marks)

(b) Obtain an expression for the drag force on smooth sphere of diameter "D" moving with a uniform velocity "V" in a fluid of density " ρ " and dynamic viscosity " μ ". (5 marks)

(c) (i) Define the following terms:-
Model, prototype and model analysis. (3 marks)

(ii) A pipe of diameter 1.8m is required to transport oil of specific gravity 0.8 and viscosity 0.004 Ns/m^2 at the rate of 4m^3/sec. Tests were conducted on a 20cm diameter pipe using water at 20^{0}c. Calculate the velocity and the rate of flow on the model (viscosity of water at 20^{0}c is 0.001Ns/m^2). (6 marks)