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KENYATTA UNIVERSITY

EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN GAS AND PETROLEUM ENGINEERING

EPL 206: FLUID MECHANICS II

1ST SEMESTER 2022/2023 **TIME: 2 HOURS**

INSTRUCTIONS:

1. **THIS PAPER CONTAINS FIVE QUESTIONS.**
2. **QUESTION ONE IS COMPULSORY AND CARRIES 30 MARKS.**
3. **ATTEMPT QUESTION ONE AND ANY OTHER TWO QUESTIONS FROM THE REMAINING FOUR QUESTIONS.**
4. **THE REMAINING FOUR QUESTIONS CARRY 20 MARKS EACH.**

QUESTION ONE: [COMPULOSORY QUESTION – 30 MARKS]

(a) What is the physical meaning of Reynold's Number? (3 marks)

(b) A viscous incompressible liquid with coefficient of dynamic viscousity ŋ steadily flows through a rectangular passage of width b, very small depth h, length L in the direction of flow under a differential pressure p. Derive an expression for:

i. Velocity profile of the liquid in m/sec

ii. Rate of steady flow in (m/sec)

iii. Mean velocity(m/sec

iv. Maximum velocity (m/sec)

v. Shear stress at the wall

(c) A laminar flow of liquid of coefficient of dynamic viscousity $\eta = 0.9\frac{kg}{m/sec}$, and density $\rho = 1260 kg/m^3$ occurs between a pair of horizontal parallel stationary plates of extreme width, the plates being 10mm apart. The pressure gauges at two points in the direction of motions are 250kN/m^2 and 80 kN/m^2 respectively. If b=0.1m, calculate the:

i. discharge (m3/sec) (2 marks)

ii. mean velocity (m/sec) (2 marks)

iii. maximum velocity (m/sec) (2 marks)

iv. shear stress at the wall (N/m^2) (2 marks)

[Total = 30 marks]

QUESTION TWO [20 MARKS]

(a) The pressure rise [P] in a pump depends on the impeller diameter (dm), rotational speed $N\ \eta m$, the mass density of the fluid $\varrho kg/m^3$, the coefficient of dynamic viscosity $\eta \frac{kg}{m/se}$ and discharge Q m^3/sec.

Show by dimensional analysis that the pressure rise P is given by:

$$P = \varrho N^2 d^2 \oint \left(\frac{Q}{Nd^3}\right)\left(\frac{\varrho N d^2}{\eta}\right)$$ (12 marks)

(b) A centrifugal pump running at 1000 ηm, generating a head of 12.2m delivers water at the rate of 0.0151m^3/sec. Calculate the head generated by a similar pump of twice the size when operating under geometrically similar conditions and discharging 0.0453m^3/sec.

(8 marks)

[Total = 20 marks]

QUESTION THREE [20 MARKS]

(a) Show that Head loss due to sudden enlargement (HL) of a pipe is given by:

$$H_L = \left[\frac{a_2}{a_1} - 1\right]^2 \frac{V_2^2}{2g}$$ (10 marks)

where a_1=cross sectional area of the pipe before enlargement.

a_2= cross sectional area of the pipe after enlargement

V_2=velocity of flow in the larger part of the pipe

(b) A 120 mm diameter pipe conveying 1.9m^3/mm of water suddenly enlarges to 240mm diameter.

Calculate the: i. Head loss due to the enlargement (2 marks)

ii. Pressure difference between the two sections (4 marks)

iii. New loss due to the enlargement (4 marks)

[Total = 20 marks]

QUESTION FOUR [20 MARKS]

Two water reservoirs are connected by a pipe ABC. The length of the section AB is 30m and is 600mm in diameter, while the remaining length BC is 40m long and is 300mm in diameter. The coefficient of attraction of the pipe is 0.002. The coefficients of friction for the pipes AB and BC are 0.006 and 0.007 respectively. The difference in water levels between the two reservoirs is 12m.

(i) Tabulate the head losses (6 marks)

(ii) Calculate the volumetric flow rate through the pipe (14 marks)

Take in account, entry, friction, sudden enlargement, sudden contraction and exit losses

[Total = 20 marks]

QUESTION FIVE [20 MARKS]

(a) Determine the conditions for maximum transmission of power through a pipe assuming loss of head by friction only. Work from first principles and explain the meaning of all symbols used. (4 marks)

(b) Derive an expression for the relationship between a nozzle diameter to pipe diameter for maximum power transmission. (4 marks)

(c) Water from a reservoir flows through a pipeline of length L and diameter d. The loss of head in the nozzle is k x$\frac{V_n^2}{zg}$ while k is a constant and V_n the velocity at the nozzle and f the friction coefficient for the pipe show that for maximum pair transmitted through the pipeline:

$$\frac{d_n}{d} = \left[\frac{(l-k)d}{8fL}\right] d^{1/2}$$ (6 marks)

(d) Water is supplied under a head of 270m to a pipeline of length 1050m, the diameter of the pipe being 200mm and the coefficient of friction f being 0.0075. The pipeline terminates in a nozzle of circular cross section.

Determine the i. diameter of the nozzle of the reaction of the jet of the jet is to be maximum (3 marks)

ii. power of the jet (3 marks)

Neglect all losses except friction losses

[Total = 20 marks]