higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

FLUID MECHANICS N6

(8190216)

15 April 2021 (X-paper)
09:00–12:00

This question paper consists of 5 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
FLUID MECHANICS N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Where applicable, use g = 9,81 m/s^2.
5. Write neatly and legibly.

QUESTION 1

1.1 Refer only to Tank A and Tank B on the DIAGRAM SHEET (attached), which are connected by two pipes in series as shown. Both connecting pipes have the same friction factor of 0,006.

Determine the following:

1.1.1 The amount of water discharged into the pipes in ℓ/s.
HINT: Use the Darcy formula (3)

1.1.2 The velocity of flow in both pipes in m/s. (4)

1.1.3 The total losses constituted by regions x, y and z in metres. Ignore the pipe friction losses. (3)

1.1.4 The hydraulic mean depth for each pipe. (4)

1.1.5 The hydraulic gradients for each pipe, if the friction heads for pipe 1 and pipe 2 are 0,788 m and 11,411 m respectively. (4)

1.2 Tank B discharges into Tank C (see FIGURE 1, DIAGRAM SHEET 1, attached) by means of two pipes P and Q which run parallel, equal in length and unequal in cross sectional areas. Both pipes have the same coefficient of friction. If the total discharge is 1,5 m^3/s, determine the quantity in each pipe in m^3/s. (4)

[22]

QUESTION 2

2.1 Tank C discharges water through an orifice of 35 mm (see FIGURE 1, DIAGRAM SHEET 1, attached) to the ground at a rate of 0,13 m^3/min. The horizontal distance of the jet is 1,8 m while the vertical one is 0,55 m.

Determine the following:

2.1.1 The horizontal reaction of the jet on the tank (5)

2.1.2 The coefficient of contraction (6)

2.2 The trapezoidal channel, D, collects water from Tank C through the orifice and also from rain (see FIGURE 1, DIAGRAM SHEET 1, attached). It has been determined that during heavy rains 18 m^3/s of water is accumulated.

If the hydraulic gradient of this channel is 2 m for every 3 kilometre and the Chezy's constant is 55, determine whether this designed channel will cope during heavy rains.

Substantiate your answer. (9)

[20]

QUESTION 3

3.1 A single-acting plunger pump has a stroke of 355 mm and a plunger diameter of 80 mm. The suction pipe has a diameter of 110 mm and is 9 m long. There is a negative suction head of 5 m. The pump is used to pump petrol with a relative density of 0,77. The atmospheric pressure is 101 kPa, and vapour pressure at the temperature of the petrol is 1,4 kPa. Assume simple harmonic motion for the plunger and determine the maximum speed in rev/s at which the crankshaft can be run before cavitation takes place. (10)

3.2 Water is raised to a height of 25 m by a single-acting plunger pump with a bore of 130 mm and a stroke length of 280 mm. The pump speed is 39 r/min. Ignore friction and calculate the following:

3.2.1 The discharge in ℓ/s

3.2.2 The power required by the pump

(2 × 2) (4)

3.3 The peripheral speed of an impeller in a centrifugal pump is 9 m/s. The impeller diameter is 1,2 m. Entrance to the impeller is radial and the exit velocity has a radial component of 1,5 m/s. The outlet vanes of the impeller are set back with an angle of 38°. Determine the torque exerted to the pump shaft if the pump delivery is 3 m^3/min. (6)

3.4 A fan extracts 9,3 m^3/s air through a duct 793 mm in diameter and of a certain length. If the coefficient of friction is 0,00225 and the pressure needed to overcome friction of the duct is 198,3 Pa, determine the length of the duct. (5)

[25]

QUESTION 4

4.1 In an inward flow reaction turbine the supply head is 14 m and the maximum discharge is 0,4 m^3/s. External diameter = 2 (internal diameter) and the velocity of flow is constant and equal to $0{,}17\sqrt{2gH}$. The runner vanes are radial at inlet and the runner rotates at 295 r/min. The hydraulic efficiency is 81 % and the vanes occupy 11% of the circumference.

Determine the following:

4.1.1 The velocity of flow (2)

4.1.2 The guide vane angle (6)

4.1.3 The vane angle at exit for radial discharge (4)

4.1.4 The external and internal diameters (in mm) (3)

4.1.5 The width of the runner at inlet and exit (in mm) (6)

4.2 In a Pelton wheel the diameter of the bucket circle is 950 mm and the deflection angle of the buckets 160°. The jet diameter is 75 mm. The relative velocity decreases by 14% as the water traverses the bucket surfaces. The rotating speed of the wheel is 300 r/min and the pressure behind the nozzle is 700 kPa. Assume the coefficient of velocity of the nozzle to be 0,98.

Calculate the following:

4.2.1 The power developed by the wheel (10)

4.2.2 The hydraulic efficiency (2)
[33]

TOTAL: 100

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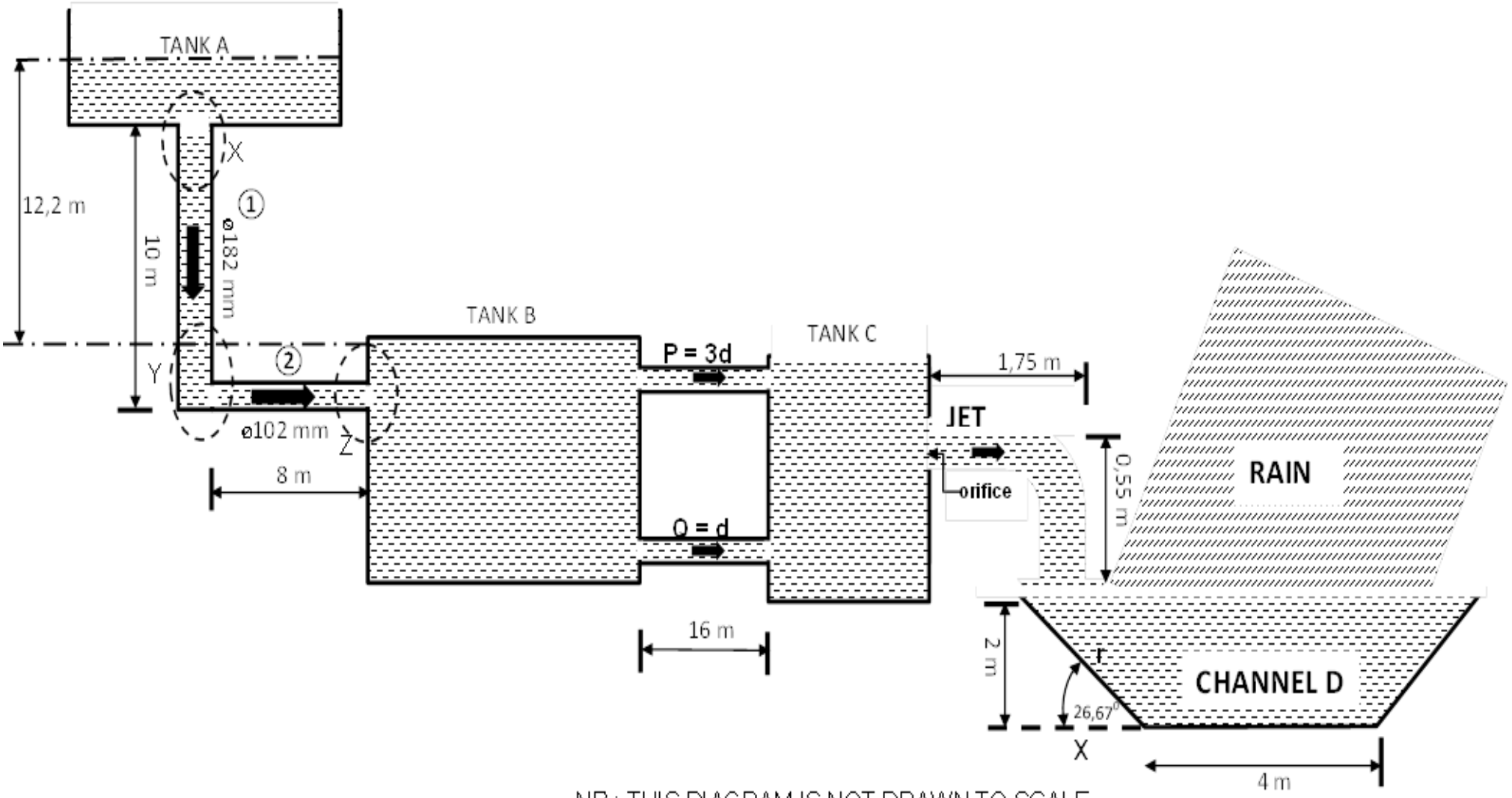

NB : THIS DIAGRAM IS NOT DRAWN TO SCALE

DIAGRAM SHEET 1 FIGURE 1