

1st SEM. 2019 / 2020



**UNIVERSITY OF ESWATINI**  
**RESIT EXAMINATION PAPER**  
**2019**

**PROGRAMME: BSC. ABE**

**COURSE CODE: ABE405**

**TITLE OF PAPER: SOILS AND FLUID MECHANICS**

**TIME ALLOWED: TWO (2) HOURS**

**SPECIAL MATERIAL REQUIRED: CALCULATOR**

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS.**

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**SECTION ONE: COMPULSORY**

**QUESTION ONE**

**(40marks)**

- a) Give one example how clays are used in the following fields. (8 marks)
- i) Oil drilling
  - ii) Construction
  - iii) Health
  - iv) Agriculture
- b) List four factors that affect the nature and extent of the diffuse double layer of clays. (8 marks)
- c) Define the following terms. (8 marks)
- i) Specific surface
  - ii) Cation Exchange Capacity
  - iii) Flocculation
  - iv) Dispersion
- d) Give three distinct differences between a liquid and a gas. (6 marks)
- e) Name the three primary thermodynamic variables of any system. (6 marks)
- f) A pipeline with an inside diameter of 200 mm and 340 m in length made of new PVC is laid along a horizontal grade. The required flow rate in the pipeline at steady state is 40 l/s and the total head available at the inlet is 330 kPa. Compute the working pressure at the discharge point 340 m from the inlet.  
Use  $C = 150$  for PVC. (4 marks)

**SECTION II: ANSWER ANY TWO QUESTIONS****QUESTION TWO****(30marks)**

- a) A moist soil sample weighs 346 g. After drying at 105°C its weight is 284 g. The specific gravity of the mass and of the solids is 1.86 and 2.70 respectively.

Calculate the following;

- i) The water content (3 marks)
  - ii) The void ratio (5 marks)
  - iii) The degree of saturation (3 marks)
  - iv) The porosity (2 marks)
- b) Using the physical and index properties of soils, show that the volume of voids  $V_v$  can also be written as;
- $$V_v = \frac{e}{1+e} * V \quad (7 \text{ marks})$$
- c) Water flows in a 10 cm diameter pipe at a mean velocity of 1.5 m/s;
- i) Calculate the discharge of the pipe in  $\text{m}^3/\text{s}$  (7 marks)
  - ii) The mass rate of flow in kg/s (3 marks)

**QUESTION THREE****(30marks)**

- a) Consider a steady flow of water through a nozzle in which the upstream diameter  $D_1 = 30$  cm reduces to a downstream diameter of  $D_2 = 20$  cm. For a flow rate of  $0.08 \text{ m}^3/\text{s}$ ;
- i) Compute the mean velocities for the upstream and downstream diameters. (8 marks)
  - ii) Assuming the nozzle is horizontal, the flow is steady and neglecting changes in internal energy of the fluid, determine the pressure change through the nozzle between the upstream and downstream end of the nozzle. (10 marks)
- b) Water flows in a very big trapezoidal channel having a bottom width of 15 m and side slopes of 1 vertical to 1.5 horizontal at a rate of  $200 \text{ m}^3/\text{s}$ . Determine whether the flow is subcritical or supercritical given that the depth of flow is 2 m. (12 marks)

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**QUESTION FOUR**

**(30marks)**

- a) Water flows in a 1000 m long pipeline of diameter 200 mm at a velocity of 5 m/s. Given that the kinetic viscosity is  $1.007 \times 10^{-6} \text{ m}^2/\text{s}$  and the friction factor of 0.021,
- Calculate the Reynolds Number and classify the flow in the pipeline. (6 marks)
  - Determine the headloss in the pipeline. (6 marks)
- b) A lake has a maximum depth of 60 m. If the mean atmospheric pressure at the site is 91 kPa, calculate the absolute pressure at the bottom of the lake. (6 marks)
- c) A test of the density of soil in place was performed by digging a small hole in the soil, weighing the extracted soil, and measuring the volume of the hole. The soil (moist) weighed 895 g. The volume of the hole was  $426 \text{ cm}^3$ . After drying, the sample weighed 779 g. Of the dried soil, 400 g was then vibrated and tampered to a volume of  $212 \text{ cm}^3$ . Given that  $G = 2.71$ ;  $\gamma_w = 1 \text{ g/cm}^3$ , find the relative density ( $D_r$ ) of the soil. (12 marks)