



MACHAKOS UNIVERSITY

University Examinations 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 400: FLUID MECHANICS IV

DATE: _____

TIME: _____

INSTRUCTIONS

1. *This paper contains five questions.*
2. *Question one is compulsory and carries 30 marks.*
3. *Four remaining questions carry 20 marks each.*
4. *Attempt question one and any other two.*

QUESTION ONE (THIRTY MARKS)

- a) An oil of specific gravity 0.92 and viscosity 0.03 poise is to be transported at the rate of 2500 L/sec through a 1.2 m diameter pipe. Tests were conducted on a 12 cm diameter pipe using water at 20⁰ C. If the water at 20⁰ C is 0.01 poise. Determine
- i. Velocity of flow in the model (5 marks).
 - ii. Rate of flow in the model (2 marks)
- b) State seven reasons why centrifugal pumps are preferred over reciprocating pumps (7 marks)
- c) List the effects of cavitation (3 marks)

- d) The following particulars relate to a reciprocating pump not fitted with air vessels: stroke 0.3m plunger diameter 125 mm, diameter of suction pipe 75 mm; length 6m, suction head 3m. Atmospheric pressure is equivalent to 10.2 m of water and separation may be assumed to occur when the absolute head in the cylinder falls below 2.4 m of water. Calculate the maximum speed at which the pump may run if separation is avoided. (5 marks)
- e) State the main parts of a Pelton wheel with their functions (8 marks)

QUESTION TWO (TWENTY MARKS)

The impeller of a centrifugal pump is of 300 mm diameter and 50 mm width at the periphery and has blades whose tip angle incline backwards at 60° from the radius. The pump delivers $17 \text{ m}^3/\text{min}$ of water and the impeller rotates at 1000 rpm. Assuming that the pump is designed to admit radially. The mechanical efficiency is 95% and hydraulic efficiency is 75%. Calculate

- i. Speed and direction of water as it leaves the impeller.
- ii. Torque exerted by the impeller on water.
- iii. Shaft power required.
- iv. Lift of the pump.

QUESTION THREE (TWENTY MARKS)

- a) A single-acting reciprocating pump, running at 5 rpm delivers $0.00736 \text{ m}^3/\text{s}$ of water. The diameter of the piston is 200 mm and stroke length 300 mm. The suction and delivery heads are 3.5 m and 11.5 respectively. Determine
- i. Theoretical discharge (2 marks).
 - ii. Co-efficient of discharge (2 marks).
 - iii. Percentage slip of the pump (2 marks).
 - iv. Power required to run the pump (3 marks).
- b) A “three throw” (triple cylinder) pump has cylinders of 250 mm and stroke of 500 mm each. The pump is required to deliver $0.1 \text{ m}^3/\text{s}$ at a head of 100 m. Friction losses are

estimated to be 1 m in suction pipe and 19 m in delivery pipe velocity of water in delivery pipe is 1 m/s, overall efficiency is 85% and the slip is 3 %. Determine

- i. The speed of the pump (5 marks).
- ii. The power required to run the pump (5 marks).

QUESTION FOUR (TWENTY MARKS)

- a) What are the functions of a turbine in a power plant? (2 marks)
- b) A reaction turbine works at 450 rpm under a head of 120 m. Its diameter at inlet is 120 cm and flow area is 0.4 m^2 . The angles made by absolute and relative velocities at inlet are 20° and 60° respectively, with the tangential velocity. Determine
 - i. The volume flow rate.
 - ii. The power developed.
 - iii. The hydraulic efficiency. Assume whirl at outlet is zero (15 marks).
- a. Discuss the difference between a Pelton Wheel and a Francis turbine (3 marks).

QUESTION FIVE (TWENTY MARKS)

- a) State and describe the four types of vortices (8 marks).
- b) Determine the lift and drag coefficients for the supersonic, symmetric airfoil shown in air ($\gamma=1.4$) at an angle of attack of 5° in figure 5.1 (12 marks).

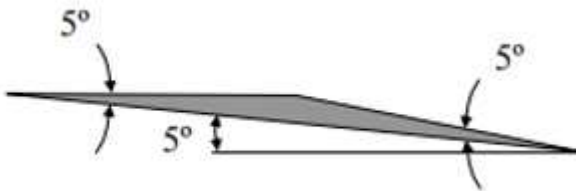


Figure 5.1

