Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 5 – EXAMINATION – SUMMER 2026

Subject Code: 2151903 **Date: 30/05/2026**

Subject Name: Fluid Power Engineering

Time: 02:30 PM TO 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1 **(a)** List any six critical factors that must be considered while selecting a site for a hydropower plant. **03**

(b) Classify hydropower plants based on the operating head of water. Briefly explain the characteristic features of a low-head power plant. **04**

(c) Derive an expression for the force exerted, work done, and efficiency of a jet striking a series of moving curved vanes mounted on the periphery of a wheel. Prove that the maximum efficiency is 50 % for a series of flat vanes. **07**

Q.2 **(a)** Briefly explain the fundamental concept of jet propulsion in ships. **03**

(b) State four major advantages and four disadvantages of a hydropower plant in the context of power generation. **04**

(c) A jet of water of diameter 50 mm, having a velocity of 25 m/s strikes a single curved vane which is moving with a velocity of 10 m/s in the exact direction of the jet. The jet strikes the vane symmetrically at the center and is deflected through an angle of 120°. Calculate: **07**

i. The force exerted by the jet on the vane in the direction of motion.
ii. The work done per second by the jet on the vane.
iii. The resultant force exerted on the vane.

OR

(c) A Pelton wheel is to be designed for the following specifications: Shaft power = 11,772 kW; Net head = 380 m; Speed = 750 rpm; Overall efficiency = 86 %. The jet ratio is not to exceed 6. Assuming the coefficient of velocity $C_V = 0.985$ and the speed ratio $K_u = 0.45$, determine: **07**

i. The diameter of the wheel
ii. The diameter of the jet
iii. The number of jets required.

Q.3 **(a)** Briefly explain why the governing of hydraulic turbines is necessary and name the governing mechanism typically used for a Pelton wheel. **03**

(b) Briefly explain the primary function of a draft tube in a reaction turbine. Why is it not used in an impulse turbine? **04**

(c) A Kaplan turbine runner is to be designed to develop 9100 kW of shaft power. The net available head is 5.6 m. The speed ratio is 2.09 and the flow ratio is 0.68. The overall efficiency is 86 % and the diameter of the boss is one-third the diameter of the runner. Calculate: **07**

i. The diameter of the runner
ii. The specific speed of the turbine.
iii. The speed of the turbine in rpm.

OR

Q.3 **(a)** Explain the fundamental working principle of a Kaplan turbine. **03**

(b) Define a centrifugal pump. Classify centrifugal pumps based on the type of casing and the working head. **04**

(c) A single-acting reciprocating pump has a plunger diameter of 250 mm and a stroke length of 350 mm. The speed of the pump is 60 rpm and it delivers 16.5 liters/s of water. The suction and delivery heads are 3.5 m and 20 m respectively. Find: **07**

i. The theoretical discharge and the coefficient of discharge.
ii. The percentage slip of the pump.
iii. The theoretical power required to drive the pump.

Q.4 **(a)** List the essential components of a reciprocating pump and state the primary function of an air vessel. **03**

(b) What is meant by the 'priming' of a centrifugal pump? State why it is an essential step before starting the pump. **04**

(c) Derive an expression for the specific speed of a pump. **07**

OR

Q.4 **(a)** Clearly differentiate between the phenomena of 'Surging' and 'Choking' in a centrifugal compressor. **03**

(b) Enlist the essential components of a centrifugal compressor and briefly state the function of each. **04**

(c) Draw the inlet and outlet velocity vector diagrams for the impeller of a centrifugal compressor featuring radial vanes. Apply the principle of angular momentum to derive the expression for the theoretical head (Euler's head) developed by the compressor. Briefly explain how the 'slip factor' modifies this ideal theoretical head. **07**

Q.5 **(a)** Define the aerodynamic terms 'Lift' and 'Drag' with respect to the aerofoil blading used in an axial flow compressor. **03**

(b) Differentiate between a fluid coupling and a fluid torque converter. **04**

(c) A two-stage reciprocating air compressor operates between suction pressure P_1 and delivery pressure P_3. Derive the mathematical condition required to achieve minimum work input per cycle, assuming complete and perfect intercooling. Prove that under this condition, the intermediate pressure is the geometric mean of the suction and delivery pressures [$P_2 = \sqrt{(P_1 \times P_3)}$]. **07**

OR

Q.5 **(a)** Explain the working principle of a hydraulic ram with the help of a neat, labeled sketch. **03**

(b) Describe the mechanism by which a hydraulic intensifier increases the pressure intensity of a fluid from a low-pressure source. **04**

(c) What is the primary function of a hydraulic accumulator in a fluid power system? Draw a neat sketch of a weight-loaded hydraulic accumulator, explain its working mechanism, and state its practical applications. **07**

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