PROJECT ABSTRACT

Centrifugal Pump Test Rig

A working centrifugal pump test rig built around a 0.5 HP monoblock pump on a welded steel frame — with suction/delivery gauges, rotameter and energy meter — where students plot head–flow, power and efficiency curves from their own readings. Delivered built-to-order with the fabricated rig, instruments and complete viva kit.

01. Title

Centrifugal Pump Test Rig

02. Introduction / Background

Fluid mechanics students study the centrifugal pump characteristic curves — head vs discharge, power vs discharge, efficiency vs discharge — in every textbook, but many college labs lack a working rig, so the curves remain theory on a page. This project fabricates a complete, bench-scale centrifugal pump test rig: a monoblock pump on a welded MS frame, a closed-loop sump circuit, suction and delivery Bourdon gauges, a delivery gate valve for throttling, a rotameter with a volumetric tank cross-check, a non-contact tachometer and an energy meter on the motor supply. The student runs the full experiment — priming, throttled operating points, steady-state readings — and computes total head, hydraulic power and efficiency from their own gauge and meter data, plotting the three characteristic curves and identifying the best-efficiency point.

03. Problem Statement

Textbook curves are memorized but rarely measured: without a dedicated rig, students never record their own operating points or reconcile a calculated efficiency with a real energy-meter reading. The project addresses this by providing a fabricated, lab-safe test rig with real instruments, so every number in the report — head, discharge, input power, speed — comes from the student's own test run, and the viva discussion is grounded in real procedure and real data.

04. Objectives

- Fabricate a bench-scale test rig around a 0.5 HP single-phase monoblock pump on a welded MS-angle frame with anti-vibration mounts.
- Provide suction and delivery Bourdon gauges so total head is computed from real pressure readings.
- Enable throttled operating points from shut-off to wide-open flow via a delivery gate valve.
- Give dual flow measurement — a rotameter plus a volumetric collection tank — for cross-checked discharge readings.
- Measure electrical input at every operating point with an energy meter for an honest efficiency calculation.
- Record motor speed at every point with a non-contact tachometer to support the affinity-law discussion.

- Supply blank observation and calculation sheets plus curve templates so the report is built from the student's own data.
- Deliver the complete student kit: rig, instruments, procedure manual, report, PPT and viva Q&A.;

05. Proposed Methodology

The build is developed in three stages. (1) Fabrication: the frame is welded, the sump tank, pump, piping, gauges, rotameter, volumetric tank and valve are mounted and plumbed in a closed loop, and the tachometer and energy meter are commissioned. (2) Testing: after priming, the student records the full instrument set at full-open flow, then throttles the delivery valve in steps toward shut-off, waiting for steady flow at each position before recording. (3) Analysis: total head is computed from the gauge difference plus gauge-centre elevation, discharge from the rotameter (cross-checked with a timed tank fill), hydraulic power as $\rho \cdot g \cdot Q \cdot H$, input power from the energy meter over a timed interval, and efficiency as their ratio — then the H–Q, P–Q and η–Q curves are plotted and the best-efficiency point located from measured data.

06. System Architecture / Working

Water recirculates in a closed loop: sump tank → pump suction (suction gauge) → pump → delivery line with rotameter and gate valve (delivery gauge) → volumetric tank → back to sump via overflow. The gate valve sets the system resistance; each throttle position moves the operating point along the pump's characteristic. The suction and delivery gauges give the pressure rise, the rotameter (checked against the timed tank fill) gives discharge, the energy meter on the supply gives input power, and the tachometer gives speed at every point. All instruments are student-read; no pre-filled curves exist anywhere in the kit.

07. Hardware / Software Requirements

- 0.5 HP single-phase monoblock centrifugal pump (~2800 RPM nameplate)
- Welded MS-angle frame with anti-vibration mounts (approx. 900 × 500 × 700 mm)
- Bourdon pressure gauges: 0–2.5 bar suction, 0–4 bar delivery (typical)
- Gate valve for delivery throttling
- Rotameter plus volumetric measuring tank with level scale
- Non-contact digital tachometer and energy meter
- GI/PVC piping, foot valve and strainer
- Approx. 60 L HDPE sump tank; 230 V single-phase supply
- No software required — analysis is done on the supplied calculation sheets.

08. Expected Outcomes

- A working, lab-safe centrifugal pump test rig with real instrumentation.
- Student-measured H–Q, P–Q and η–Q characteristic curves with the best-efficiency point located from their own data.
- A worked comparison of the measured curve against the pump's rated duty point.
- Documented test procedure, blank observation sheets and a complete report, PPT and viva Q&A.;

09. Applications

- Fluid-mechanics teaching laboratories and pump-performance practicals.
- Demonstrating throttling effects and the affinity-law discussion with real speed data.
- Student fabrication, plumbing and instrumentation experience on a real rig.

10. Future Scope

- Variable-speed drive on the pump for affinity-law verification at multiple speeds.
- Digital pressure transducers with data logging in place of mechanical gauges.
- Testing different impeller trims to compare characteristics.
- Cavitation demonstration module (optional extension).