# Safety Hazards
# Fluid Machinery Laboratory Room B-10

**HAZARD:** Rotating Equipment

Be aware of pinch points and possible entanglement

**Personal Protective Equipment**: Safety Goggles; Standing Shields, Sturdy Shoes
**No:** Loose clothing; Neck Ties/Scarves; Jewelry (remove); Long Hair (tie back)

**HAZARD:** Projectiles / Ejected Parts

Articles in motion may dislodge and become airborne

**Personal Protective Equipment:** Safety Goggles; Standing Shields

**HAZARD:** Electrical - Burn / Shock

Care with electrical connections, particularly with grounding, and not Using frayed electrical cords, can reduce hazard. Use GFCI receptacles near water.

**HAZARD:** High Pressure Air-Fluid / Gas Cylinders / Vacuum

Inspect system integrity before operating any pressure / vacuum equipment. Gas cylinders must be secured at all times.

**Personal Protective Equipment:** Safety Goggles

**HAZARD:** Water / Slip Hazard

Clean any spills immediately.

**HAZARD:** Laser / Eye - Cornea Damage

Do not look directly into laser

**Personal Protective Equipment:** Laser Specific Goggles

## ME 406: Experiment 5

## CENTRIFUGAL PUMPS IN SERIES AND PARALLEL

### I. Objective:

To determine the head-capacity characteristics separately for each of two 1 1/2 inch LLR-7 centrifugal pumps.

To determine the head-capacity characteristics of these two pumps when they operate collectively in a series system configuration.

To determine the head-capacity characteristics of those two pumps when they operate collectively in a parallel system configuration.

To determine the characteristics of the piping system.

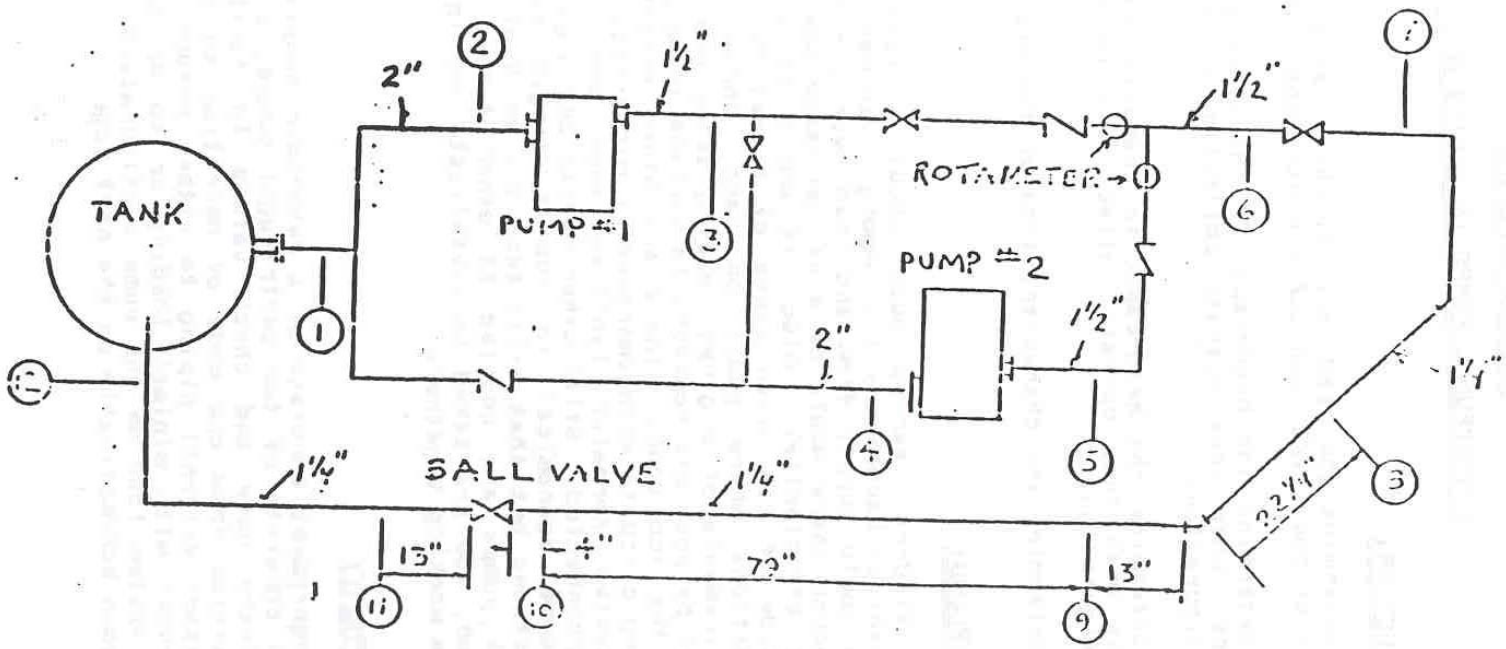
### II. Background:

The student learned much about a centrifugal pump in Mechanical Laboratory II. Among these were the facts that a pump could supply flow and head over A range of conditions although there would be a narrow range where it could do it most efficiently. Also it would be unable to operate outside of its given range of operation. There are many situations where pumps on hand cannot individually meet the requirements of a given piping setup and constraints. It might be possible however, to harness these pumps together to get the job done. There are other situations in complex piping circuits when emergencies might require that parts of a system normally isolated from one another must be interconnected. Still other operations might dictate that it is more economical to run a single pump for certain operations but that efficiency can be kept high if two (or more) pumps are coupled at other times. For whatever reasons you are asked to investigate the interaction of two pumps working together.

### III. Equipment:

The equipment consists of a reservoir supplying a test loop which consists of two centrifugal pumps a flow meter, the necessary gate and check valves to facilitate the easy transition from one mode of operation to another, and the necessary external piping to either return the flow to the reservoir with minimal loading or to deliberately place a high system load on the pump configuration This test loop is shown schematically on the next page.

# 1½ LLR-7 TEST LOOP




SCH. 80 PVC PLASTIC PIPING

## IV. Procedure:

1. Determination of individual pump characteristics

   a) Start pump #1 and run it at five different flow rates, maximum to shut off.
   b) For each of the flow rate measure the inlet and outlet pressures using the pressure taps closest to these locations.
   c) Repeat a) and b) for pump #2.

2. Determination of series pump characteristics

   a) Start both pumps and run them at five different flow rates, maximum to shut off.
   b) For each of the flow rates, measure the inlet pressure closest to the inlet of pump #1 and discharge pressure closest to the outlet of pump #2.

3. Determination of parallel pump characteristics

   a) Run both pumps in parallel from maximum to shut-off using at least six different flow rates.
   b) At each flow rate record the discharge pressure at the junction of discharge piping from two pumps, the inlet pressure at the joint inlet to both pumps, and the flow rate through each pump.

NOTE: all of the above tests are to made using the large 3 inch return line to the reservoir with the valve wide open and the 1 ¼ return line shut completely off.

4. Determination of return system characteristics

   a) Run the pumps in parallel with the 3-inch line completely closed and the 1 ¼ inch line with the ball valve half open.
   b) Vary flow rate from maximum to shut-off in six steps.
   c) At each flow rate measure the flow rate through each pump, the pressure just downstream of the flow control valve, and the pressure just prior to return to the reservoir.

## V. Analysis

1. Plot measured head-capacity curves for each pump on the same sheet.

2. Plot measured head-capacity curve for the pumps in series. Graphically construct the head-capacity curve from the data of Part 1 and superimpose on this same sheet.

3. Plot measured head-capacity curve for the pumps in parallel. Graphically construct the head-capacity curve from the data of Part 1 and superimpose on the same sheet.

4. Plot the head-capacity curve for the system. Superimpose the measured head-capacity curve for the parallel operation on this sheet.