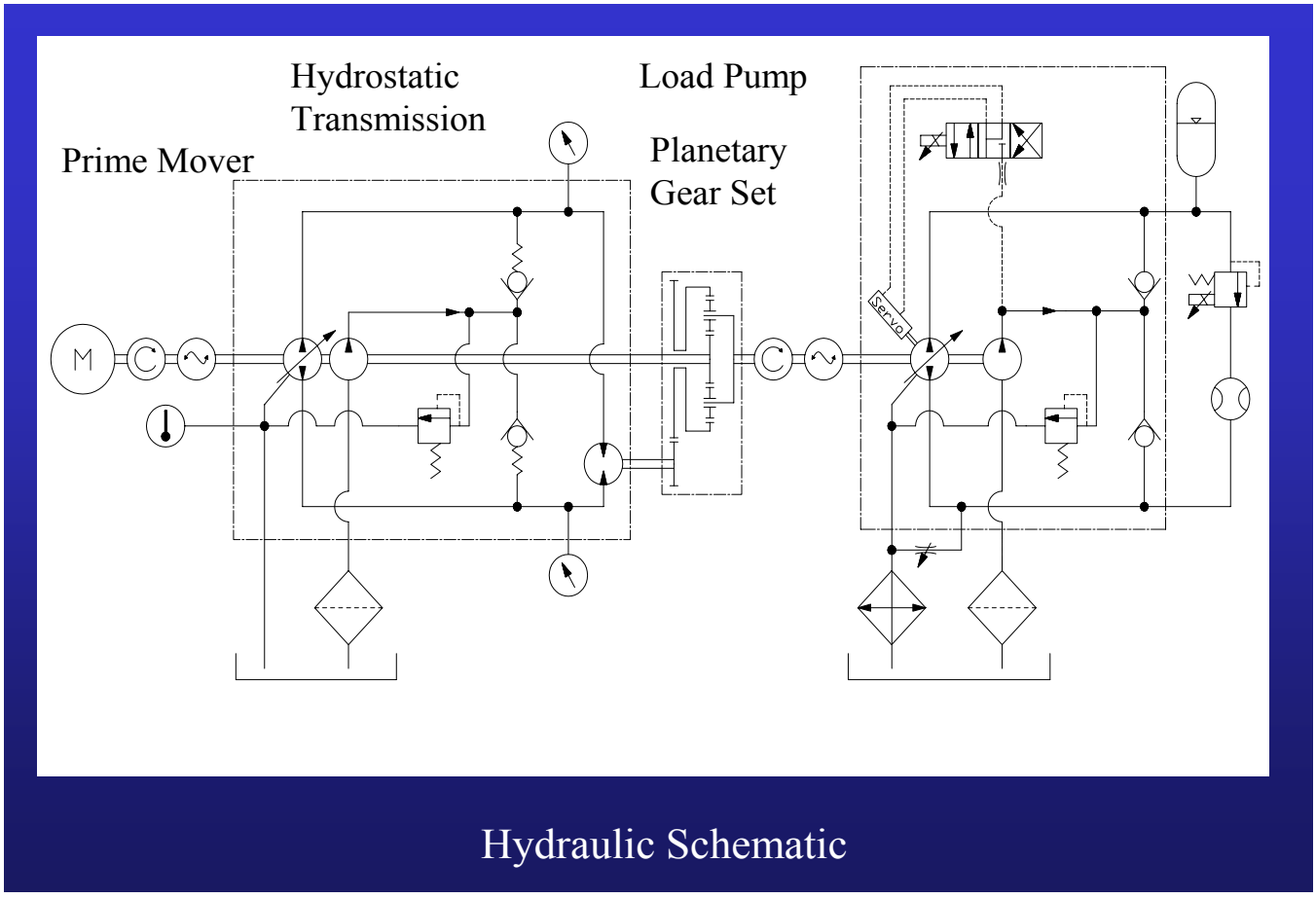
HYDRO-MECHANICAL TRANSMISSIONS

OBJECTIVE:

To acquaint the students with hydro-mechanical transmission. The student is expected to understand the basic operational principles of the transmission, how the gear ratio is adjusted, and the effect of load torque on hydrostat pressures and power transmission.

THEORY:

The hydro-mechanical transmission tested consisted of a hydrostatic transmission connected to a simple planetary gear set. The variable displacement hydrostat pump and sun gear planetary are directly connected to the engine. The fixed displacement hydrostat motor is connected to the ring gear with a gear ratio of 44/36. That is if the hydraulic motor is rotating at 440 RPM, the ring gear rotates at 360 RPM. The output of the hydro-mechanical transmission is the carrier. The planetary gear set has 57 teeth on the ring gear and 27 teeth on the sun gear. Remember that $(N_r-N_c)/(N_s-N_c) = -T_s/T_r$, where N = RPM and T = No. teeth. A schematic of the hydro-mechanical transmission is given below. The pump (at full stroke) and motor displacement is 0.913 in^3/rev (15 cm^3/cm).



Hydraulic Schematic

For the system the following equations hold true:

$Nr = Nm * 36 / 44$

$Nm = Dp / Dm * Np *$ Volumetric efficiency of the hydrostat.

Torque of Pump (Tp) = $\Delta p(psi) * D(in^3)/(2\pi * 12)$

Power = $2\pi TN/33000$

The test stand above was used to measure the input speed (Engine/Sun/Pump Speed) and input torque (Engine Torques), the output speed (Carrier/Load Speed) and output/load torque, the ring gear speed and hydraulic gauge pressures in the hydraulic system. The results of tests are provided on the spreadsheet attached. The system was tested under three different conditions:
1) Ramping the pump swash plate angle from -15 to 15 degrees(Full negative to full positive displacement) with zero load torque on the carrier (see Figure 1 on spreadsheet).
2) Ramping the pump swash plate angle from -8 to 8 (restricted by limits of test stand) with different load torques on the carrier resulting from friction. (see Figure 2 & 3 on spreadsheet).
2) Maintaining the pump swash plate angle at a nominal 7.5 degrees while ramping the load from approximately zero to 500 in.lb load torque on the carrier. (see Figure 2 & 3 on spreadsheet).

For the three test conditions determine the following information: You will have to take the average of a number of points to do these calculations.

<u>Test Condition 1: No Load, Variable Swash Plate Angle</u>

1) The overall efficiency of hydromechanical transmission at swash plate settings of -15, 0 and +15 degrees.
2) The power lost at swash plate settings of -15, 0 and +15 degrees.

<u>Test Condition 2: Friction Load, Variable Swash Plate Angle</u>

3) The overall efficiency of hydromechanical transmission at swash plate settings of -6, 0 and +6 degrees.
4) The volumetric efficiency of hydrostatic transmission at swash plate settings of -6, and +6 degrees.
5) The power lost at swash plate settings of -6, 0 and +6 degrees.
6) What is the effect of increasing output torque on the hydraulic pressures.

<u>Test Condition 2: Friction Load, Variable Swash Plate Angle</u>

7) The overall efficiency of hydromechanical transmission at output loads 300, 500 and 700 in.lb
8) The volumetric efficiency of hydrostatic transmission at output loads 300, 500 and 700 in.lb
9) The power lost at output loads 300, 500 and 700 in.lb
10) What is the effect of increasing output torque on the swash plate angle.

This is not a formal report but all calculations must be neatly presented and all working shown.