2. Understand Hydraulic system components and their functions

A. PTO’s and Drives
   1. Types of engagement
   2. Horsepower requirements
   3. Drive line requirements

B. Hydraulic Pumps
   1. Piston
      a. Fixed displacement
         1. swash plate
      b. Variable displacement
         1. Inline
         2. Axial
         3. Compensator
      c. Pressure/flow compensating
   2. Balanced/Unbalanced vane
      a. Displacement
      3. Gear
      4. Cause of aeration and cavitation

C. Reservoir
   1. Capacity Requirements
   2. Design
   3. Location
   4. Function

D. Plumbing
   1. Hosing type, size & construction
   2. Tubing vs. Pipe
   3. How hydraulic steel tubing size is measured
   4. Proper Sealing Methods
   5. Restriction to flow
   6. Fittings
      a. Quick disconnect couplings

E. Valves
   1. Directional Valve
      a. Rotary
      b. Spool
   2. Cartridge Valve
      a. Relief valves
      b. Flow control valves
         1. Non-Compensated
         2. Compensated
      c. Modulating orifice cartridges
      d. Seating blocks
      1. Cavities
      f. Unloading valve
      1. Inlets/outlets
   3. Gear
   4. Cause of aeration and cavitation

F. Actuators
   1. Linear (cylinder)
      a. Single Acting
      b. Double Acting (differential)
         1. Seal Failure
         2. Pressure Intensification
      c. Telescoping
      d. Components of cylinders
      e. Double acting double rod
      f. Welded construction
   2. Rotary (Motor)
   3. Torque and Speed
      a. Output horsepower

G. Heat Exchangers - BTU/HR

H. Accumulators
   1. Maintaining pressure
   2. Pressure Transmitter
   3. Pressure Transducer

I. Gauges and Meters
   1. Pressure Transmitter
   2. Pressure Transducer

J. Filter media
3. Understand and identify hydraulic circuits & symbols
A. Types
1. Parallel
2. Series
3. Regenerative
4. Open Circuit
5. Closed Circuit
6. Hydrostatic Transmission
   a. Peak Torque
   b. Charge Pump
7. Open Center & Open Loop
8. Closed Center & Closed Loop
9. Load Sensing
B. Schematics & Symbols
1. Variable Motor
2. Accumulator
3. Fixed motor
4. Variable pump
5. Fixed pump
6. Filter, Strainer
7. Cooler
8. Types of Cylinder
9. Heater
10. Temperature Controller
11. Counterbalance
12. Slip in cartridge
13. Direction of flow
C. Control
1. Digital
2. Analog
3. Electro-Hydraulic
4. Conductor
   a. Fluid Velocity
5. Resistance

4. Troubleshooting, Tools and Equipment
A. Troubleshooting
1. Circuits
   a. Speed Control
   b. Flow Control
   c. Closed Loop
2. Components
   a. Pumps
      1. Cavitation causes
      2. Failure analysis
   b. Valves
      1. Counter balance
      2. Shuttle valve
      3. Load sensing
   c. Actuators
      1. Cylinders
         (i) Pressure intensification
      2. Hydraulic Motors
         (i) Shaft Failure Causes
            1) torsional failures
            2) bending shear failures
   d. Tubes, hoses, fittings
   e. Filters
B. Tools and Equipment
1. Flow meters
2. Pressure gauge sets
3. Tube fabrication
   a. Tube benders
   b. Flaring tools
   c. Proof pressure

5. Definitions
A. Unload
B. Closed Circuit
C. Reciprocation
D. Circuit
E. Demulsibility
F. Bar
G. Deadband
H. Wiper ring
I. Thermocouple
J. Solenoid
K. Hysterisis
L. Watt
M. Counterbalance Valve
N. Nominal Rating
O. Filter
P. Strainer
Q. Elastohydrodynamic Lubrication
R. Absolute rating
S. Abrasion
T. Lubricity
U. Pour Point
V. Cracking Pressure
W. Hydrokinetics
X. Drain
Y. Viscosity
Z. Actuator
AA. Specific gravity
AB. Durometer
AC. Silt
AD. Delivery
AE. Back pressure
AF. Exhaust
AG. Bleed off
AH. Bypass
AI. Full flow
AJ. Rated flow
AK. Pressure compensator
AL. Positive displacement
AM. Throttle
AN. Reversing valve
AO. Pressure transducer
AP. Pressure transmitter