Tanta University		4th Year Mech. Power
Faculty of Engineering		Final Exam – June, 2015
Mech. Power Engineering Dept.	Hydraulic and pneumatic circuits	Time: 3 hours.

- **Assume any missing or additional data.**
- **Attempt all questions.**
- **Support your answers with neat sketches whenever necessary.**

Question (1)

a. List ten hydraulic applications and ten pneumatic applications and explain the advantages and limitations of them.

b. Explain the principals of operation and the possible applications of the hydraulic accumulators.

c. In the hydraulic circuit in **Figure (Q1.c)**, the directly operated counterbalance valve is set at 40 bar.

- What does the gage read when the platen is not moving and is being suspended in mid-stroke?
- What does the gage read when the platen is approaching the material to be pressed?
- Assume that the system relief valve is set for 70 bar and that the movement of the cylinder rod is severely restricted once the platen contacts the material to be crushed. What is the maximum pressing force if the platen moves through the material during the pressing operation?

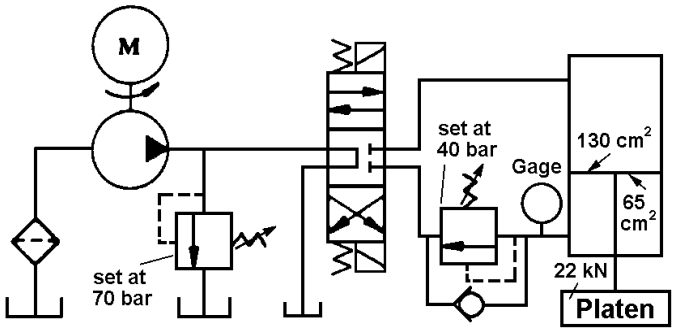

Fig. (Q1.c)

Question (2)

a. Operationally, what is the difference between a pressure relief valve and a pressure reducing valve? Draw the construction and symbol of each valve.

b. What is meant by a hydraulic pump cavitation? List a number of causes for this problem in hydraulic circuits and explain the methods that prevent it.

c. What are the differences between spool, poppet and rotary directional control valves?

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d. The two rear drive sprockets on a crawler tractor are powered with hydraulic motors through a reduction gear set as shown in **Figure (Q2.d)**. The motors are driven by a single variable displacement hydraulic pump with equal flow to each motor. Given that: Drawbar force Fd = 12 kN, Dozer force Fz = 19.5 kN, Motor inlet pressure = 30 MPa, Motor discharge pressure = 350 kPa, Motor overall efficiency = 94%, Motor mechanical efficiency = 96%, Gear ratio = 3.9:1, Tractor speed $\dot{x}$ = 4.7 km/h, Sprocket effective rolling radius R = 375 mm. Determine:

- The required motor capacity to produce the given dozer and drawbar forces.
- The required motor displacement to produce the given tractor speed, $\dot{x}$.

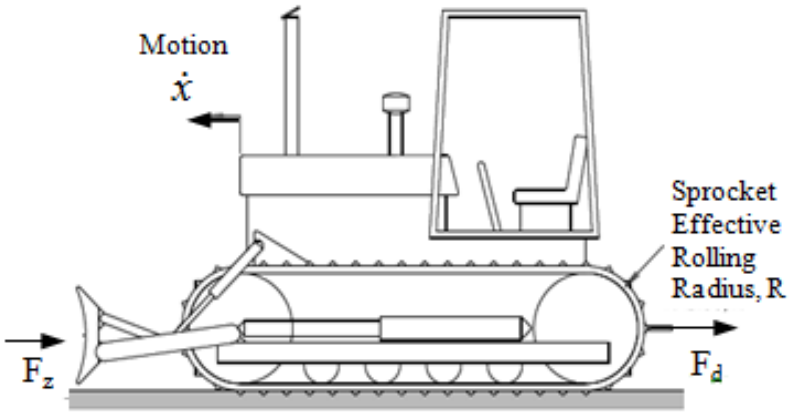

Fig. (Q2.d)

Question (3)

a. What are the differences between internal leakage and external leakage in the control valves and actuators and its effects on them? Explain how you can overcome these problems?

b. A single acting upstroking moulding press has a cylinder diameter of 400 mm, a stroke of 250 mm of which 225 mm is to close the dies onto the work piece at a cylinder pressure of 20 bar. The final 25 mm stroke is to be at a cylinder pressure of 350 bar. The press is to produce 60 components per hour. The breakdown of the required maximum operating time is:

- Rapid approach 225 mm = 5 seconds
- Pressing over final 25 mm = 5 seconds
- Cure time (i.e. hold under full thrust) = 25 seconds
- Return time = 10 seconds
- Unload and reload press = 15 seconds
- Total cycle time = 60 seconds

The return time is estimated for gravity return. The only times which are absolutely fixed are the cure and the loads times. Draw the hydraulic circuit for the system and calculate the overall system efficiency.

c. Two similar double acting hydraulic cylinders are used to push product from a vertical stack into a conveyor belt then into a container as shown in the **Figure (Q3.c)**. Draw the hydraulic circuit that will continuously remove product from the stack and fulfill the following requirements:

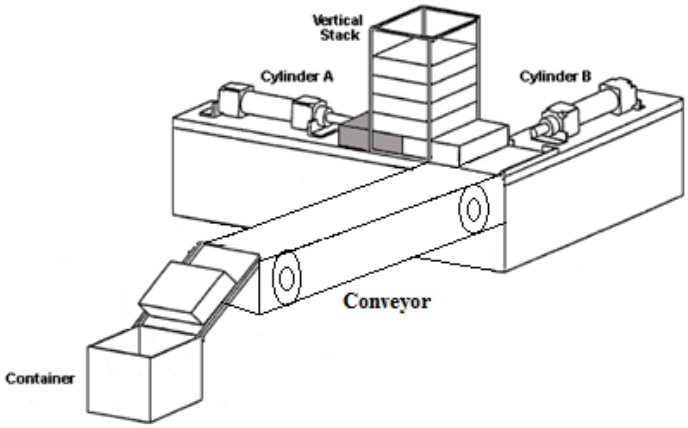

Fig. (Q3.c)

- In the active stroke, Cylinder A has to move first. Cylinder B starts to move with normal speed only when Cylinder A reaches the end of its travel.
- The extending speed of Cylinder B should be 70% of that of Cylinder A.
- Both cylinders should be able to retract together at the same time. The pressure needed for Cylinder A to retract is 20 bar and that for Cylinder B is 10 bar.
- Conveyor belt has two actuators both of them should be able to rotate together at the same time.
- Install a filter in the suction line. This filter may be blocked with oil contamination at any instant during operation.
- Install a safety circuit to prevent damage to system and injury to operating and maintenance personnel.

Question (4)

a. In an application that requires a capacity flow of 100 L/min at 180 bar. If a partial load required a pressure of only 95 bar, and a metered flow rate of 40 L/min. Determine the **total** lost energy if:

1. The system as shown in **Figure (Q4.a)** under the same condition is used.
2. A variable displacement pump under the same condition is used for the system in **Figure (Q4.a)**.
3. A load-sensing system that uses a variable displacement pump has the destroking mechanism set at 15 bar under the same condition is used.

- Using (Q-P) diagram, show a comparison among three systems based on the used, lost and unused energies.
- Explain the load-sensing system principle of operation with neat sketch.

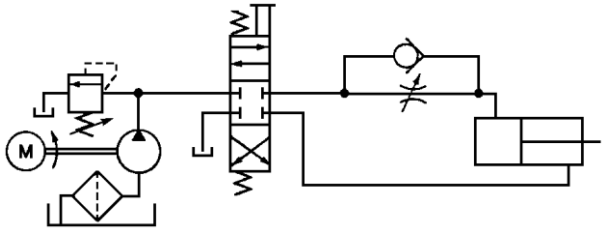

Fig. (Q4.a)

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b. For the circuit shown in **Figure (Q4.b)**.

1. Identify the numbered components,
2. Describe the circuit's operation,
3. What are the functions of components number **4, 9, 15** and **16**?
4. Explain briefly your suggestions if components number **11** and **17** are not synchronous and the application required both of them extend and return at the same time.

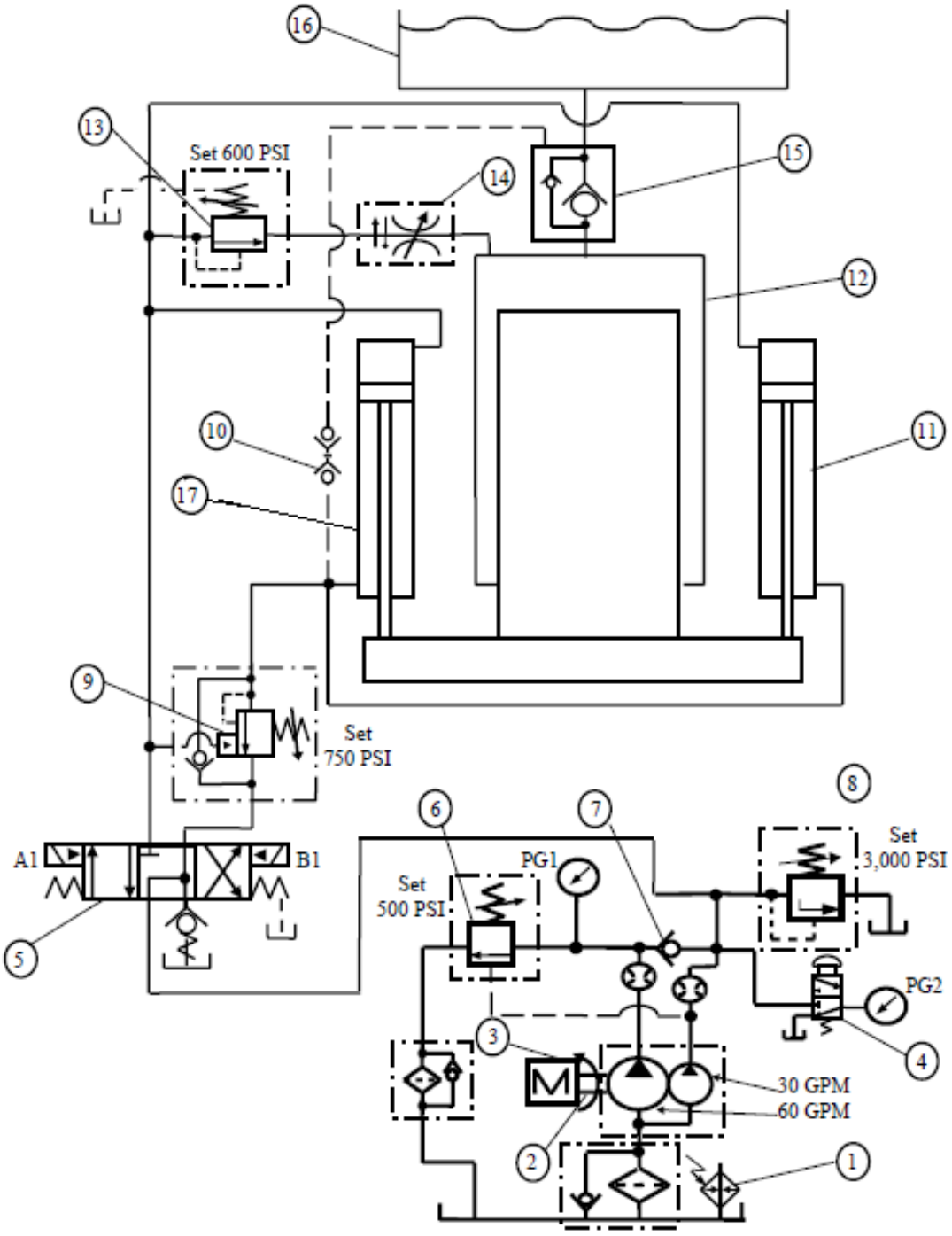

Fig. (Q4.b)

Good Luck