Kafrelsheikh University		4th Year Mech. Power
Faculty of Engineering	Hydraulic Power Systems	Final Exam – Jan., 2016
Mech. Power Engineering Dept.		Time: 3 hours.

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

الإمتحان من ورقتين كل ورقة لها وجهين

Question (1)

a. **"The proper design of a suitable reservoir for a hydraulic system is essential to the overall performance and life of the individual components"** Justify this statement and explain the construction features of a reservoir that satisfies industry's standards with neat sketch.

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

c. For the hydraulic circuit shown in **Figure (Q1.c)**, determine the pump size (Q, H and shaft power) for the operation of the shown clamping circuit, knowing that:

- Clamping thrust 100 kN. Hydraulic cylinder has piston and rod sizes of 100 and 70 mm, respectively.
- Intensifier has diameters of ratio 5 : 1.
- Speed of forward stroke until start of clamping action is 3 m/min, and cylinder load during this stroke 5 kN.
- Pump efficiency 75%.

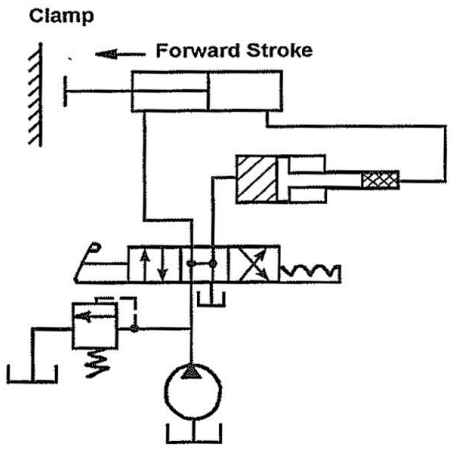

Fig. (Q1.c)

Assume no leakage occurs in the intensifier system, pipe work and connections and allow for 0.3 bar pressure drop in the 4/3 directional control valve and associated piping.

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 principle of design and operation of safety circuits with a neat sketch?

c. Explain the function and principal of operation of cushion with a neat sketch.

d. The two rear drive sprockets on a crawler tractor are powered with hydraulic motors through a reduction gear set shown in **Figure (Q2.d)**. The motors are driven by a single variable displacement hydraulic pump with equal flow to each motor. Given that: Pump capacity low = 25 mL/rev, Pump capacity high = 55 mL/rev, Pump speed = 1200 rpm, Pump volumetric efficiency = 97%, Outlet pressure = 23.5 MPa. Motor capacity = 330 mL/rev, Motor volumetric efficiency = 97%, Motor mechanical efficiency = 96%, Motor discharge pressure = 240 kPa. Gear ratio = 4.5:1, Sprocket effective rolling radius R = 375 mm. Determine:

(a) The highest and lowest tractor speeds.

(b) The tractor drawbar pull F_d at low and high pump capacities.

(c) The tractor power produced at low and high pump capacities.

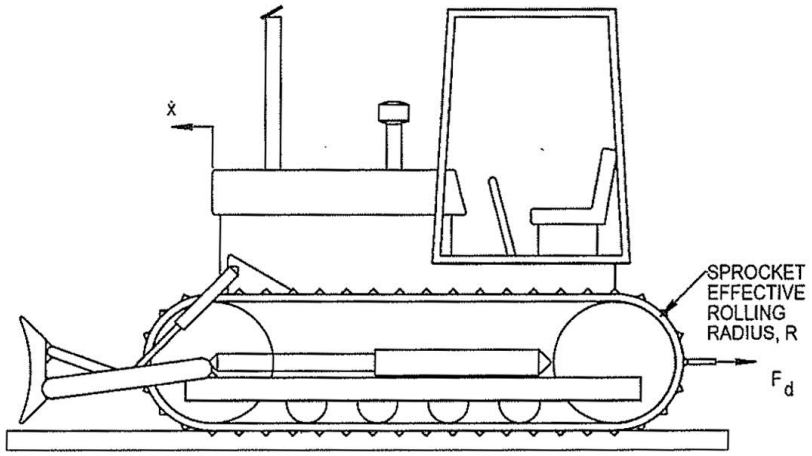

Fig. (Q2.d)

Question (3)

a. What are the differences between open-center and closed-center circuits with neat sketch?

b. A cylinder has to exert a forward thrust of 100 kN and a reverse thrust of 10 kN. The retract speed should be approximately 5 m/min utilizing full pump flow and the extend speed is 0.5 m/min. Assume that the maximum pump pressure is 160 bar and the pressure drops over the following components and their associated pipe work (where they are used):

Filter	= 3 bar
Directional valve (each flow path)	= 2 bar
Flow control valve (controlled flow)	= 10 bar
Flow control valve (check valve)	= 3 bar

Using 'Meter-in' flow control, ***draw the hydraulic circuit and determine:***

(a) The cylinder size (assume 2:1 ratio piston rod area),

(b) The pump size,

(c) The circuit efficiency.

c. An assembly device is used to press workpieces together for drilling as shown in ***Figure (Q3.c)***. Cylinder 1A1 presses a workpiece into the housing. This operation should be carried out slowly at a constant speed. When the pressure in cylinder **1A1** has reached 20 bar (workpiece pressed into place), a hole is drilled through the workpiece and housing. The drill is driven by a hydraulic motor. After the drilling operation, the drill is switched off and retracted (**1A2**). Cylinder **1A1** is retracted only when the drill has withdrawn from the housing. Draw the hydraulic circuit diagram by choosing the correct components according to the machine function and above explanation.

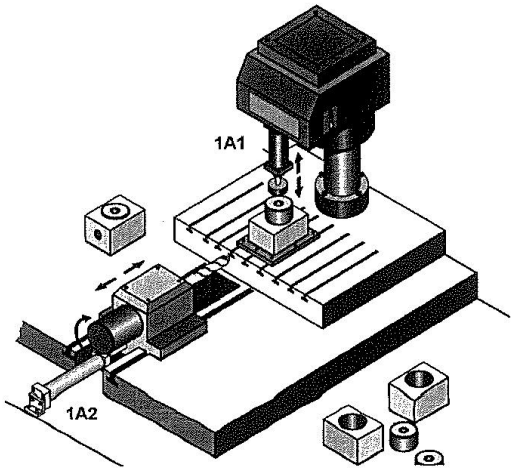

Fig. (Q3.c)

Question (4)

a. In an application that requires a capacity flow of 102 L/min at 190 bar. If a partial load required a pressure of only 100 bar, and a metered flow rate of 52 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 18 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.

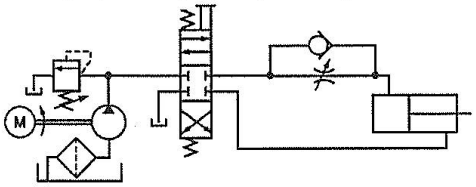

Fig. (Q4.a)

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 **6, 8** and **9**?
4. Explain briefly your suggestions if components number **1** and **3** are not synchronous and the application required both of them extend and return at the same time.

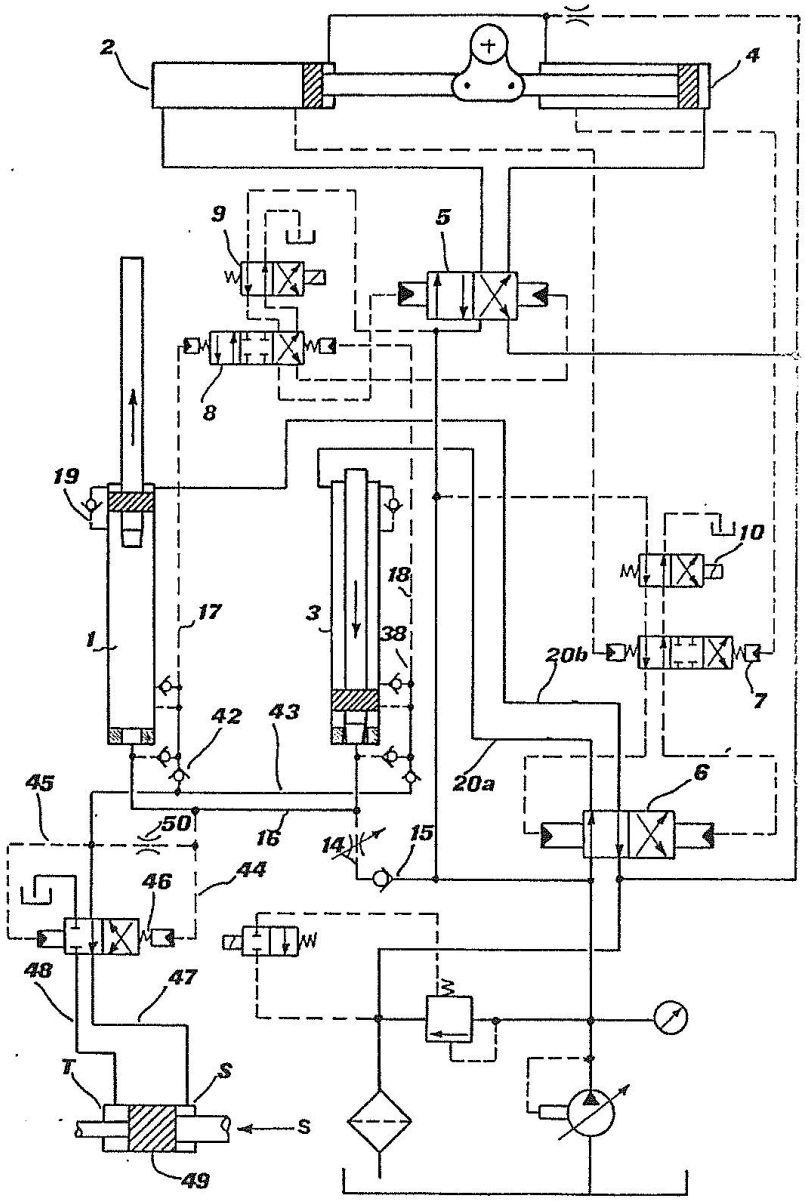

Fig. (Q4.b)

Good Luck