



Kafrelsheikh University	 	4 th Year Mechanical
Faculty of Engineering		Final Exam – Dec., 2018
Mechanical Engineering Dept.		Time: 3 hours.
Hydraulic Power Systems		
<ul style="list-style-type: none"> • 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)

- "The reservoir performs many roles in the operation of the hydraulic system" Justify this statement and explain the functions, construction and location of hydraulic reservoir *with a neat sketch*.
- How does the pilot operated pressure control valve differ from direct operated design? With two examples from the applied circuits. (*Draw the two circuits*)
- For the circuit of *Figure (Q1.c)*, explain in details the effect of the shuttle valve presence on the circuit operation. Assume a cylinder is initially fully retracted.

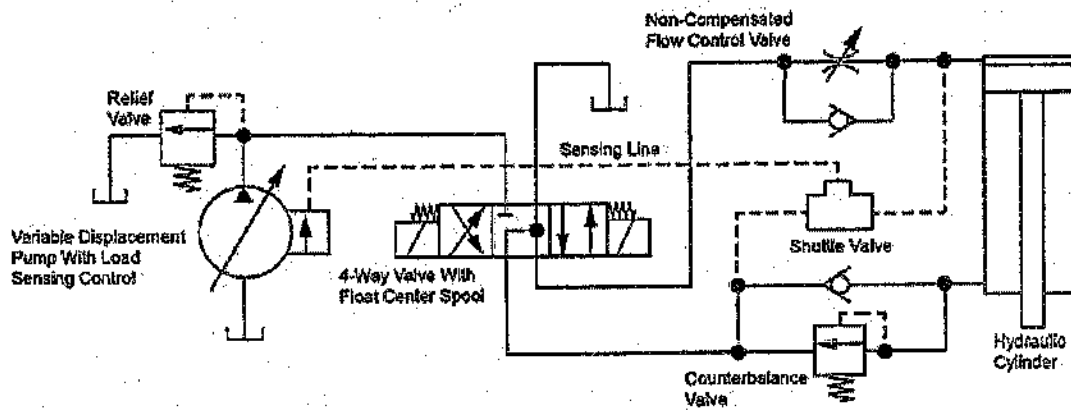


Fig. (Q1.c)

Question (2)

- Explain, how the motor type flow divider can introduce an accurate performance higher than spool type design? *Draw their mechanical construction and hydraulic symbols.*
- Operationally, explain the differences between straight or tapered cushions *with a neat sketch*.
- In a meter-in circuit, a cylinder with 100 mm bore diameter and 70 mm diameter is used to exert a forward thrust of 100 kN, with a velocity of 0.5 m/min. Neglect the pressure drop through the piping valves. If the pump flow is 20 LPM, find the following:
Pressure required at the pump on extending motion.
 1. Flow through the flow-control valve.
 2. Relief-valve setting.
 3. Flow out of the pressure-relief valve.
 4. System efficiency during extending motion.

Question (3)

- a. What are the functions and construction of the velocity hydraulic fuse? With three from the applied circuits. (*Draw the two circuits*)
- b. List the purpose of each of the following valves and sketch of them and their hydraulic symbols: Rotary shear directional control valve, pilot operated check valve and Temperature-pressure compensated flow control valve.
- c. A double acting press has a piston diameter of 400 mm, a rod diameter of 200 mm, and 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 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
Unload and reload press	=	15 seconds

The pump speed is 1720 rpm. The pump has volumetric and overall efficiencies of 0.95 and 0.85 respectively. Using a fixed output pump, calculate:

- (a) The pump displacement volume.
- (b) The input power required for each part of the extending stroke.
- (c) The relief valve setting pressure.
- (d) The number of work pieces produced per hour.
- (e) The overall system efficiency.
- c. A machine is used to grind work part as shown in *Figure (Q3.c)*. The grinding table of a surface grinding machine is driven by *two hydraulic cylinders (crossfeed and infeed motions)*. Since *the speed is required to be the same in both directions for each hydraulic cylinder*, the hydraulic control circuit must be designed to provide compensation for the difference in volume of the two cylinder chambers for each hydraulic cylinder. The grinding wheel is driven by a hydraulic motor. The wheel head is moved vertically in both directions using *hydraulic cylinder*. **Draw the hydraulic circuit** for the assembly device to include **all** of the following requirements:
- The press of the grinding wheel into the work part should be carried out slowly at a constant speed.
 - Hydraulic motor has to have fixed torque and fixed speed.
 - Install a filter on the suction line. This filter may be blocked with oil contamination at any instant during operation.

Question (4)

- a. Compare between the four favorable filter arrangements according to circuit diagram, advantages and disadvantages of each of them.
- b. For the circuit shown in *Figure (Q4.b)* and according the following data:
- | | | |
|--|---|----------------------|
| Opposing force on the actuator rod | = | 10 kN |
| Actuator velocity | = | 0.5 ms ⁻¹ |
| Actuator piston diameter | = | 50 mm |
| Actuator rod diameter | = | 25 mm |
| Relief valve set pressure (P_{smax}) | = | 100 bar |
| Pump flow | = | 80 L/min |

The pressure in the return line from the actuator can be assumed to be zero.

1. Determine the size (rated flow) of the restrictor valve (L/min) that is to be used for controlling the velocity during extension of the actuator at a rated pressure drop of 10 bar.
2. Show how the circuit can be modified in order that the extending actuator velocity will be controlled when the force is negative (pulling). Calculate the actuator pressures if the force given in the data is pulling the actuator rod.
3. In order to prevent the actuator velocity changing with changes in the load force a pressure compensated flow control valve can be used in place of the restrictor valve. Draw a sketch of this type of valve and briefly describe its method of operation.

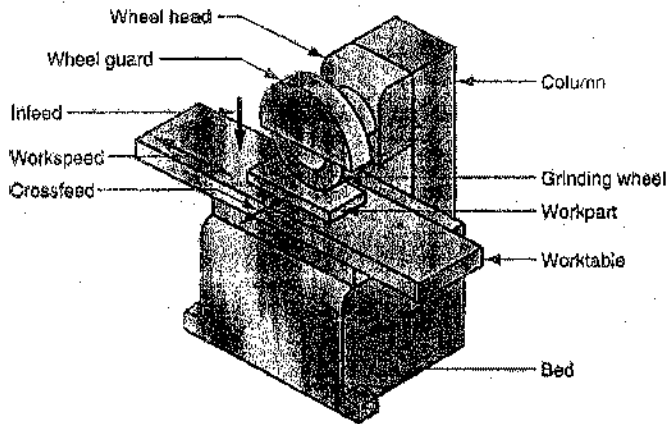


Fig. (Q3.c)

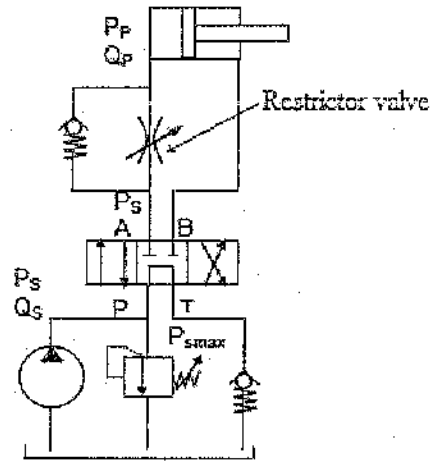


Fig. (Q4.b)

- c. An assembly device is used to press-fit a plastic bush into a steel workpiece as shown in *Figure (Q4.c.1)*. Design the hydraulic control circuit of this device to meet the operational requirements and state diagrams in *Figure (Q4.c.2)*.

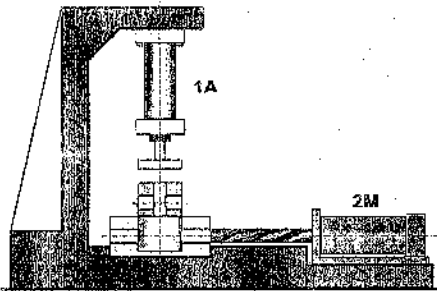


Fig. (Q4.c.1)

Components			Time						
Description	Code	Status	Step						
			1	2	3	4	5	6	
Cylinder	1A	2		▲	■	▼			
		1	■						
Motor	2M	2		■					
		1	■						

Fig. (Q4.c.2)

- d. For the circuit shown in *Figure (Q4.d)*.
1. Identify the numbered components,
 2. Describe the circuit's operation,
 3. What are the functions of components number 1, 3, 4, 5, 6, 7, 8, 9 and 10?
 4. What happens if components 1 and 14 include reverse flow valve?

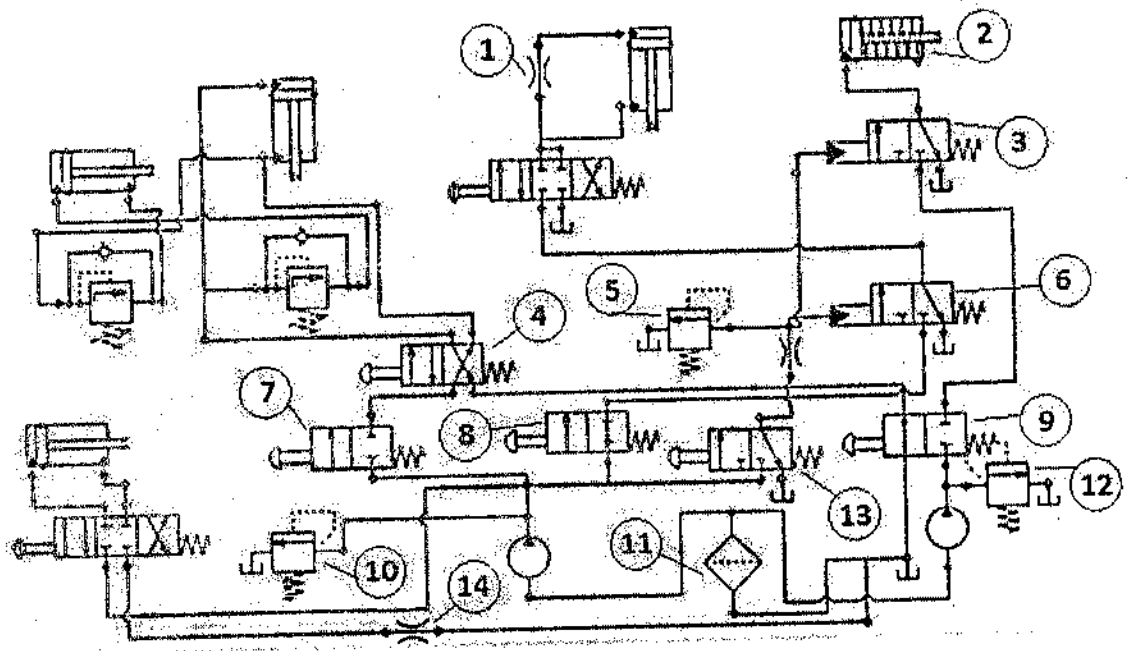


Fig. (Q4.d)

Good Luck