Appendix A: Answers to Chapter Questions

Introduction

The questions at the end of each chapter is designed to test your understanding of the chapter. Use this appendix to verify your answers for the chapter questions.
Chapter 2 Quiz Answers

1. An ohm (Ω) is the unit of electrical resistance.

2. The symbol for a diode can be shown as: The current is shown flowing to the right.

3. If the resistance increases and the voltage remains constant, the power does NOT increase. 
   (Hint - use the formula \( P = \frac{V^2}{R} \))
   If the resistance increase and the voltage remains constant, the current does NOT increase.
   (Hint - use the formula \( I = \frac{V}{R} \))

4. A Voltmeter is used to measure Electromagnetic force.

5. A Voltmeter or an Ammeter can be used to measure power.

6. Beginning  Ending
   \[ I = \frac{14V}{10.2\,\Omega} \]
   \[ I = \frac{9\,V}{10.2\,\Omega} \]
   \[ I = 1.3725\,\text{Amps} \]
   \[ I = 0.8824\,\text{Amps} \]

7. a) calculate the resistance of the wire. \((0.2\,\Omega/\text{ft.}) \times 30\text{ft} = 0.6\,\Omega\)
   b) multiply a) by 2 for one wire between the battery and coil and another one from the coil to the battery. \(2 \times 0.6 = 1.2\,\Omega\)
   c) add the resistance of the wire and coil by assuming they are resistors in parallel
      \(7.2\,\Omega + 1.2\,\Omega = 8.4\,\Omega\)
   d) current draw of the system is
      \[ I = \frac{V}{R} \]
      \[ I = \frac{12\,V}{8.4\,\Omega} \]
      \[ I = 1.43\,\text{Amp} \]
   e) voltage drop across the coil
      \[ V = IR \]
      \[ V = (1.43\,\text{Amps}) (7.2\,\Omega) \]
      \[ V = 10.3\,\text{V} \]

8. If a system can provide 10 watt, this is a measure of power.

9. a) First determine the power:
   \[ P = I^2 R \]
   \[ P = (2 \,\text{amps})^2 (6\,\Omega) \]
   \[ P = 24\,\text{watts} \]
   b) Since 24 watts are needed and only 20 watts are available, there is not sufficient power to drive the coil.

10. \[ \frac{1}{R_{\text{total}}} = \frac{1}{4\,\Omega} + \frac{1}{5\,\Omega} + \frac{1}{8\,\Omega} = \frac{1}{0.575\,\Omega} = 1.74\,\Omega \]
    \[ I = \frac{V}{R} = \frac{24\,V}{1.74\,\Omega} = 13.8\,\text{Amp} \]

11. A full wave bridge rectifier is used to change AC into DC.
Chapter 3 Quiz Answers

1. One reason to increase the number of turns on a solenoid is to increase the magnetic field or flux of the coil.

2. The magnetic field lines represent the path in which the magnetic field flows.

3. Yes, the current flowing through a wire does affect the direction in which a compass points. The direction in which the compass points indicates the direction in which the magnetic force is exerted.

4. If a piece of iron was in a solenoid and the current was turned on, a steel wrench would be attracted to the iron.

5. The wrench would remain attracted to the iron due to hysteresis (residual magnetism).

6. Ferromagnetism is the ability to acquire high magnetism in relatively weak external magnetic fields.

7. Residual magnetism is magnetism that remains in the iron parts after the solenoid is turned off.

8. The magnetic field is proportional to the number of turns.
Chapter 4 Quiz Answers

1. The parts of the solenoid electromagnetic actuator include: pole piece, armature, solenoid coil winding, yoke (frame), guide tube, push pin.

2. A flat face armature is used when a lot of force at a small air gap is needed.

3. The factors which determine the shape or level of force in the Force vs Air gap curve are:
   a) shape of the pole piece and armature (ie conical or flat face)
   b) current applied
   c) amount of iron in shell
   d) coil resistance / temperature

4. Yes, increasing the shell thickness will increase the force as long as the armature is not saturated.

5. Increasing the current increases the magneto-motive force (NI)

6. a) convert from °F to °C
   \[
   \left(\frac{20-32}{1.8}\right) = -6.67 \degree C
   \]

   b) determine the resistance at -6.67 °C
   \[
   R_c = 7.2\Omega \left(1 + 0.00393 (6.67 - 20)\right) \\
   R_c = 6.44\Omega
   \]

7. The coil can draw more current at the same voltage if the resistance is lower. The increased current increases the NI or magneto-motive force.

8. The type of armature to be used against this force is a proportional. The reason for this is the proportional actuator applies constant force regardless of the air gap.

9. The proportional style actuator is the most expensive because there are more detailed features with tighter tolerances. The higher tolerances are required so each actuator is the same, and so that the force is constant regardless of the air gap.

10. The flat face actuator is the least expensive because there is very little detail in these parts.

11. The plunger would be attracted to the pole piece because there is no force opposing it.
Chapter 5 Quiz Answers

1. A magnet wire is insulated to keep each wire from touching the next.

2. HydraForce uses class H, 180° wire, with a continuous duty rating of 20,000 hours, as standard in its coils.

3. HydraForce defines continuous duty as having the coil installed in a 100° C ambient environment with 115% of rated voltage.

4. The components which make up the frame are the shell and washers.

5. The temperature range in which the coil can operate in is, -40° C - 100° C.

6. The start slot is used to protect the first wire during winding.

7. The type of termination used in the material handling industry is typically a dual spade.

8. The parts of the coil include: termination, shell, winding and encapsulant.

9. HydraForce uses glass filled Rynite™ as standard in coils.

10. The six standard sizes of HydraForce coils are: 01,08,10,12,60 & 70.

11. The voltage range standard coils operate in ±15% of nominal.

12. HydraForce uses the random winding process as standard.
Chapter 6 Quiz Answers

1. The shell is external so that it does not crack the encapsulant when there are extreme temperature changes.

2. Since the dual spade termination is not waterproof, the winding is wound on a bobbin because it is less costly to wind on a bobbin.

3. The inserts are used to protect the winding during molding and provide a location for the terminal pins.

4. The advantages of molding the connector into the coil are that it is weatherproof and does not require strain relief.

5. The advantages of the waterproof coil are that there are no waterproof o-rings and no special nuts or cartridge adaptors.

6. The winding used in the waterproof coil is a bobbin-less or free standing one.
Chapter 7 Quiz Answers

1. The proof pressure of an SF08 tube subassembly is 7000 psi.

2. A spring is present in a solenoid valve to return the valve to the de-energized position.

3. The function of the poppet and cage seat is to keep oil from flowing from port 2 to 1.

4. The cage is heat treated to improve wear resistance.

5. The spool is ground to reduce friction.

6. Brazing is the joining of two parts. HydraForce uses copper for this process.

7. The proof pressure of an SV)* tube subassembly is 3500 psi.

8. The balancing grooves trap oil, which helps center the spool and reduces friction.

9. The plug in the push style tube is made from stainless steel so the plunger is not attracted to it.

10. The “T” slot is a connection between the plunger and spool or pilot pin. It allows for misalignment between the parts so that the parts are still able to move easily.

11. The poppet and poppet cage are made from steel with no lead, because the lead melts during the heat treating process, leaving small voids on the surface which allows oil to leak.

12. HydraForce springs are typically made of music wire.
Chapter 8 Quiz Answers

1. Two ways to measure the actuator force are by connecting a force measuring device (Load Cell) to the plunger or by using Finite Element Analysis.

2. The spring force is not a fixed force, rather it is a variable force.

3. The free length of the spring is the uncompressed length of the spring.

4. The spring force increases when the coil is energized.

5. The Bernoulli force is caused by an acceleration of oil as it goes from a larger passage to a smaller one.

6. When fluid passes from a larger area to a smaller area there is a drop in pressure.

7. The port numbers are a designation for passage of fluid.

8. The term used when the spool allows fluid to pass through to other ports in the transition position is open or negative lap.

9. The term used when the spool does not allow fluid to pass through to other ports in the transition is closed or positive lap.

10. Two types of friction forces discussed in the chapter are mechanical and viscous.

11. The type of force which pulls water together to form a drop is viscous.

12. The area of the pilot pin exposed to low pressure is the area which sits on the seat.

13. The term which describes the de-energized coil is drop out.

14. The forces acting on the spool valve are: actuator force, spring force, flow force and friction force.

15. Pull in occurs when the armature has travelled fully through the air gap from the de-energized to the energized position.

16. The surface finishes of the cage and spool are both less than 10 µ in.

17. Pull in of the normally open poppet valve occurs when the coil is energized. The magnetic force overcomes the spring and the plunger pushes down on the push pin and pilot pin. This action closes off the pilot pin seat and then the poppet closes off the cage seat.

18. The pressure force acting on the pilot pin occurs when the pilot pin is seated, because the coil is energized. The pressure acts all around the pilot pin except where it is seated. This small area is why there is a pressure force on the pin.
Chapter 9 Quiz Answers

1. The type of actuator used in the SV08-47A is a 3 position type. It has 2 energized positions and one neutral or de-energized positions.

2. The SV in the model code designates a Solenoid Valve.

3. True. A normally opened valve does allow oil to flow between the two ports when no power is applied.

4. The left side of the hydraulic symbol designates the energized position.

5. A check valve allows flow in one direction.

6. The SV08-47D is known as the motor spool because this valve is often used to control the direction of rotation of the hydraulic motor.


8. The screen option is used to protect the valve from large contaminants floating through the system.

9. The standard seal type which HydraForce uses is Buna N.

10. The term which describes the hardness of the seal is durometer.
Chapter 10 Quiz Answers

1. The term used to describe the induced voltage when power is turned on and off is back EMF.

2. A surge suppressor is used to prevent damage from back EMF.

3. The three types of surge suppressors discussed are: diode, varistor, bidirectional zener diode.

4. The advantage of the varistor over the diode is that it does not matter which way you connect the varistor to the power supply.

5. The zener diode is similar in function to the varistor.

6. When installing the coil, the lettering should face up (facing the hex nut).

7. Before the cartridge is inserted into the cavity, it should be properly lubricated to allow the seals to slide more easily, as well as preventing extrusion.

8. If the nut on the 08 size cartridge is overtightened, the spool or poppet may stick, due to the inside of the cage being deformed or collapsed.