University of Cincinnati
College of Engineering and Applied Science

20MECH6031/5131 Intro to Robotics
Homework#7 - Robot Actuators and Drives (72 pts)

Student Name: Hongui Yi **Score: _____**

1. (15 pts)

An actuator refers to a component of a machine, which is able to move and control a mechanism or system to make a movement such as linear or angular displacement. For instance, by opening a valve. In short, it is a "mover".

a)

	Hydraulic systems	Pneumatic systems	Electric motors
Payload	Highest	Lowest	Good
Power/weight ratio	Highest	Lowest	Good
Accuracy	High	Low	Highest
Speed range	Wide	Narrow	Good

2. (15 pts)

	DC Motor	AC Motor
Power source	Direct current	Alternating current
With Brushes	Yes	No
Life Expectancies	Shorter	Longer
Speed Control Manner	By varying the armature winding's current	By varying the frequency of alternating current
Payload	Smaller	Larger

3. (14 pts) Stepper motor. Because articulating robot is expected to mange the back and forth movement, which is satisfied by the reversibility of stepper motors. The control accuracy is also very high.

Stepper motor. Because polar robot is expected to perform the reciprocating rotational motion, which is satisfied by the reversibility of stepper motors. The control accuracy is also very high.

Micro stepper motor. Because the data form the hard disk is small, which commands a precise control of the reading arm. Each coil of the micro stepper motor is switched on and off in many steps to satisfy the requirements.

Stepper motor. Because 3D printer 3D printers require high control accuracy and should be able to change direction of motion continuously. Stepper motor has a high accuracy and reversibility.

Stepper motor. Because the hydraulic actuating system needs frequency conversion to regulate the flow rate. A stepper motor should be used to drive the hydraulic pump.

Brushless motor. Because in a windshield system, the feedback is necessary to switch the direction of the current. Each coil of brushless motor is energized when the rotor reaches a specific location.

AC motor. Because a ceiling fan uses the capacitor phase shift to obtain a rotating magnetic field, so that the motor rotates and drives the fan blades to rotate to generate wind. The AC motor could provide the magnetic field.

4. (4 pts)
   The control method is the primary difference. Servo-controlled robot systems receive a reference position signal from the controller, which regulates the difference between the ideal position and the actual position. A non-servo-controlled robot, on the other hand, can only control the robot by sending a signal to start or stop.

5. (8 pts)
   It depends on the requirements for the speed range and the performance curve, including the aspects of the motor speed the motor torque. After that, we also need to consider the initial speed, max speed, required power, accuracy, reversibility, shape and size restrictions, if the motor torque-speed curve well matched to the load, and other aspects.

It depends on the needs of the application. When the robot is required to work in a more efficient way, then a chain should be used to drive it. When the requirement is to provide a high reduction ratio, then gears should be used. And other aspects of the real application should be considered if we need to use belts, ball screws or harmonic drives.

6. (4 pts)
   The robot drive is used to transfer power from the motor/pump/compressor to the robot axis. Also, if a reduced speed is required, a reduction drive system should be used.

7. (6 pts)

In harmonic drives, flexible spline gears are used to overcome interference between gears. It is used to increase the output torque of gears. For example, in aerospace, it is widely used in rocket and spacecraft systems to increase propulsion.

8. (6 pts)

Timing belts can be used in applications requiring high precision metrics or precise positions, as the belt is driven by tooth contact, which provides the ability to precisely control the position.