



**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL
(TVET CDACC)**

Qualification Code : 071606T4MCT
Qualification : Mechatronic Technician Level 6
Unit Code : ENG/OS/MC/CR/02/6/A
Unit of Competency : Install Mechatronic Systems

WRITTEN ASSESMENT

INSTRUCTIONS TO ASSESSOR:

1. The candidate has **TWO HOURS** to attempt all the questions.
2. Marks for each section are indicated in the brackets
3. The paper consists of **TWO** sections: **A** and **B**.
4. The candidate is required to attempt **ALL** questions from section **A** and **ANY THREE** questions from section **B**.
5. The candidate is provided with answer booklet for their responses.

NB: These only serves as a guide to expected responses.

SECTION A: SHORT ANSWER QUESTIONS (40 MARKS)

1. List four sources of possible errors in sensing instruments. (4 marks)
 - ✓ **Gross Error**
 - ✓ **Systematic**
 - ✓ **Random errors.**
2. Define the following terms (3 marks)
 - i. Sensor
 - ✓ **A sensor is a device that receives and responds to a signal**
 - ii. Actuator
 - ✓ **An actuator is a device that actuates or moves something.**
 - iii. Transducer
 - ✓ **A transducer is any device which converts one form of energy into another.**
3. Outline three advantages of a conduit wiring system. (3 marks)
 - ✓ **Metallic conduits provide a high degree of fire protection**
 - ✓ **The rigidity of conduit permits installation with fewer supports than the other types of wiring systems.**
 - ✓ **Conduits can be sized to provide the easy installation of the additional conductors in the conduit.**
4. Explain the difference between active and passive sensors. Give two examples of each type of sensor. (4 marks)
 - ✓ **Active sensors have its own source of light or illumination. In particular, it actively sends a pulse and measures the backscatter reflected to the sensor.**
 - ✓ **But passive sensors measure reflected sunlight emitted from the sun. When the sun shines, passive sensors measure this energy.**
5. Explain the function of each of the following pipe fittings: (3 marks)
 - i. elbow;
 - ✓ **An elbow is installed between two lengths of pipe (or tubing) to allow a change of direction**
 - ii. tee;
 - ✓ **A tee, the most common pipe fitting, is used to combine or divide fluid flow**

- iii. socket.
- ✓ **A socket is a fitting that simply goes over the end of a pipe.**
6. List the four factors that must be considered when selecting a wire insulation. (4 marks)
- ✓ **Circuit voltages**
 - ✓ **Surrounding temperature conditions**
 - ✓ **Moisture**
 - ✓ **Conductor flexibility**
 - ✓ **Being resistant to fire, oil, or liquid fuels.**
7. State four properties of a GI pipe. (4 marks)
- ✓ **Higher durability and longevity.**
 - ✓ **Weld consistency and integrity.**
 - ✓ **Amenable to rigorous fabrication.**
 - ✓ **Superior finish and anti - rust coating.**
 - ✓ **Greater resistance to corrosion.**
 - ✓ **Superior bend ability, ease of cutting and threading.**
 - ✓ **Strict adherence to quality standards.**
8. Explain the following stepper motor terminology
- i. Pull-out torque (2 marks)
 - ✓ **Pull-out torque is the maximum torque that can be delivered without losing steps.**
 - ii. Pull-in torque (2 marks)
 - ✓ **Pull-in torque is the maximum torque at which a motor can start rotating at a given frequency.**
 - iii. Dynamic torque (2 marks)
 - ✓ **Dynamic torque is the quantity related to the power on a mechanism that is rotating.**
9. List the three types of conductors that are recognized by the National Electrical Code (NEC). (3 marks)
- ✓ **Copper**
 - ✓ **Aluminum**
 - ✓ **Copper-clad aluminum**
10. List the three major sections of an electronic variable frequency drive, and state the main function performed by each. (6 marks)

- ✓ **Rectifier section.** The full-wave, three-phase diode rectifier converts the 60-Hz power from a standard utility supply to either fixed or adjustable DC voltage.
- ✓ **Inverter section.** Electronic switches—power transistors or thyristors—switch the rectified DC on and off, and produce a current or voltage waveform at the desired new frequency.
- ✓ **Control section.** An electronic circuit receives feedback information from the driven motor and adjusts the output voltage or frequency to the selected values. Usually, the output voltage is regulated to produce a constant ratio of voltage to frequency (V/Hz). Controllers may incorporate many complex control functions.

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SECTION B: EXTENDED ANSWER QUESTIONS (60 MARKS)

11.

- i. Discuss the advantages and disadvantages of pneumatic actuation system. (10 marks)

Advantages of Pneumatic Actuators:

- ✓ **simplicity of realization relatively to small back and forth motions;**
- ✓ **sophisticated transfer mechanisms are not required;**
- ✓ **low cost;**
- ✓ **high speed of moving;**
- ✓ **ease at reversion movements;**
- ✓ **tolerance to overloads, up to a full stop;**
- ✓ **high reliability of work;**
- ✓ **explosion and fire safety;**
- ✓ **ecological purity;**
- ✓ **ability to accumulation and transportation.**

Disadvantages of Pneumatic Actuators:

- ✓ **compressibility of the air;**
- ✓ **impossibility to receive uniform and constant speed of the working bodies movement**
- ✓ **difficulties in performance at slow speed;**
- ✓ **limited conditions – use of compressed air is beneficial up to the definite values of pressure;**
- ✓ **compressed air requires good preparation**

- ii. In the past, unsatisfactory test probes and voltage indicators have frequently been the cause of accidents. The Health and Safety Executive (HSE) has published a guidance note (GS 38) which advise electricians and other electrically competent people on the selection of suitable test probes. Discuss five features that all test probes must incorporate according to GS 38. (10 marks)

- ✓ **The probes must have finger barriers or be shaped so that the hand or fingers cannot contact the live conductors under test.**
- ✓ **The probe tip must not protrude more than 2 mm, and preferably only 1 mm, be spring-loaded and screened.**

- ✓ **The lead must be adequately insulated and coloured so that one lead is readily distinguished from the other.**
- ✓ **The lead must be flexible and sufficiently robust.**
- ✓ **The lead must be long enough to serve its purpose but not too long.**
- ✓ **The lead must not have accessible exposed conductors even if it becomes detached from the probe or from the instrument.**
- ✓ **Where the leads are to be used in conjunction with a voltage detector they must be protected by a fuse.**

12.

- i. Describe the advantages and disadvantages of DC motor. (10 marks)

Advantages of DC Motor

- ✓ **DC motors are smaller in size.**
- ✓ **These motors operate on DC supply then they can be used in electronics devices.**
- ✓ **DC motors are suitable for traction systems for driving heavy loads.**
- ✓ **DC series motors have will high starting torque.**
- ✓ **Wide range of speed control.**
- ✓ **DC Shunt motors are best suited for armature control and field control.**
- ✓ **DC motors have quick starting, stopping, reversing, and fast acceleration.**
- ✓ **DC motors are free from harmonics.**

Disadvantages of DC Motor

- ✓ **DC motors have a high initial cost.**
- ✓ **Maintenance cost is high and increased operation due to the presence of brushes and commutator.**
- ✓ **Due to sparking at brush DC motors cannot operate in explosive and hazardous conditions.**
- ✓ **As the speed increases, the shaft gets vibrated and the armature gets damaged.**
- ✓ **We need converters to supply power to the motor.**

- ii. Describe the five steps involved in successfully finding an electrical fault. (10 marks)

- ✓ **Gather *information* by talking to people and looking at relevant sources of information such as manufacturer's data, circuit diagrams, charts and schedules.**
- ✓ **Analyse the evidence and use standard tests and a visual inspection to predict the cause of the fault.**
- ✓ **Interpret test results and diagnose the cause of the fault.**
- ✓ **Rectify the fault.**
- ✓ **Carry out functional tests to verify that the installation or piece of equipment is working correctly and that the fault has been rectified.**

13. Different factors must be kept in mind when you are selecting any wiring system Discuss ten factors to consider. (20 marks)

- ✓ **Type of Building**
 - ✓ **If we install a conduit wiring on a abortive wall of building then we see that after some duration the conduits are loose and automatically fall on to the floi1r of the buildings or hanged on the walls. If we install a conduit wiring on cemented wall of a building, then this wiring system is durable because the conduits are cannot looses. So always choose the wiring system according to type of building.**
- ✓ **Voltages**
 - ✓ **We know that the supply company is recommended the 220V for single-phase wiring system and 440v for three-phase wiring system. Therefore, the design of an installation is always depending upon the supply voltages.**
- ✓ **Nature of Work in Building**
 - ✓ **It is recommended that always choose the wiring system according to nature of work in building.**
- ✓ **Weather Condition**
 - ✓ **The regulations relate to weather conditions, always exposed to hazardous environments.**
- ✓ **Durability**
 - ✓ **The recommended wiring systems have a durable and also has a well strength. The design of wiring system is selected according to nature of work.**
- ✓ **Safety**

- ✓ **Always choose the correct size of cable because if you choose the correct size of cable then this cable easily handles the load current and no any risk of fire and leakage are present in wiring system.**
- ✓ **Economical**
 - ✓ **It is recommended that the selected wiring system must be economical, well looking and also have a good efficiency.**
- ✓ **Flexibility**
 - ✓ **A good electrical system provides flexibility. The wiring system accommodates future physical changes**
- ✓ **Switch Gears**
 - ✓ **The switch gear used in wiring system must be withstanding the fault condition; If we' install a switch gear according to correct rating of circuit then our system work properly and in abnormal condition disconnect the wiring system through supply.**
- ✓ **Availability of Material**
 - ✓ **Always confirm, before starting wiring system that the material for selected wiring system is easily available in market.**
- ✓ **Beauty of Building**
 - ✓ **The wiring must provide a good look after its installation.**

14.

- i. Discuss five important static characteristics of sensors. (10 marks)
- ✓ ***Sensitivity* is a measure of the change in output of the sensor relative to a unit change in the input (the measured quantity.)**
 - ✓ ***Resolution* is the smallest amount of change in the input that can be detected and accurately indicated by the sensor.**
 - ✓ ***Linearity* is determined by the calibration curve. The static calibration curve plots the output amplitude versus the input amplitude under static conditions. Its degree of resemblance to a straight line describes the linearity.**
 - ✓ ***Drift* is the deviation from a specific reading of the sensor when the sensor is kept at that value for a prolonged period of time.**

- ✓ **The *range* of a sensor is determined by the allowed lower and upper limits of its input or output. Usually, the range is determined by the accuracy required.**
- ✓ ***Repeatability* is defined as the deviation between measurements in a sequence when the object under test is the same and approaches its value from the same direction each time.**
- ✓ ***Reproducibility* is the same as repeatability, except it also incorporates long time lapses between subsequent measurements. The sensor has to be operation between measurements, but must be calibrated. Reproducibility is specified as a percentage of the sensor range per unit of time.**

ii. Illustrate five comparisons of pneumatic and hydraulic systems (10 marks)

Hydraulic systems	Pneumatic systems
✓ The working fluid is hydraulic oil.	✓ Working fluid is compressed air.
✓ As oil is incompressible, oil can be pressurized to very high pressure. (500 bar or even more)	✓ Air is compressible; hence air can be pressurized to lesser pressure. (Only up to 10 bar approx.)
✓ Since pressure is high, the force developed is also very high (thousands of tones).	✓ Since pressure is very less, the force developed is very less (up to 1 ton)
✓ Since pressure is high, components are very strong, made of steel, and are heavy.	✓ Components of the pneumatic system are lighter in weight, are made of aluminum.
✓ As oil has more viscosity, it cannot flow fast. Hence hydraulic systems are slower in operation.	✓ Air has very less viscosity, it can flow fast. Hence pneumatic systems are quicker in operation.

Hydraulic systems	Pneumatic systems
<ul style="list-style-type: none"> ✓ Due to continuous recirculation, the temperature of oil increases. 	<ul style="list-style-type: none"> ✓ The harder it runs, the cooler it works. Free expansion of air in cylinders and motors causes a chilling effect.
<ul style="list-style-type: none"> ✓ Hydraulic oils are petroleum-based oils; they are inflammable and there is every chance of fire hazard if neglected. 	<ul style="list-style-type: none"> ✓ No chance of fire hazard. Hence pneumatic tools are preferably used inside mines, where flammable gasses may present.
<ul style="list-style-type: none"> ✓ Leakage of oil results in dirty and slippery Surroundings that may lead to accidents. 	<ul style="list-style-type: none"> ✓ The very clean and dry surrounding is maintained.
<ul style="list-style-type: none"> ✓ The pump used is a positive displacement pump, so a pressure relief valve is necessary 	<ul style="list-style-type: none"> ✓ No need for a pressure relief valve.

Hydraulic systems	Pneumatic systems
✓ There is no need for a separable lubrication System, because, hydraulic oil itself is a lubricant.	✓ A lubricator is necessary. Oil is mixed with the compressed air in the lubricator and then supplied to the system.
✓ Applications: CNC. Machine tools, earth-moving machines, automobiles. aviation etc	✓ Applications: Material handling systems, hand tools mining works, automation, automobiles, etc.

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