071305T4EOP

ELECTRICAL OPERATION (POWER OPTION)

LEVEL 5 ENG/OS/PO/CC/01/5

APPLY ELECTRICAL

PRINCIPLES July/August 2024

Time: 3 Hours

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

WRITTEN ASSESSMENT

TIME 3 HOURS

<u>Answers</u>

SECTION A (40 MARKS)

1. **Ohm's Law**: Ohm's Law states that the current (I) flowing through a conductor between two points is directly proportional to the voltage (V) across the two points and inversely proportional to the resistance (R) of the conductor. Mathematically, it is expressed as: V=I×R$V=I\times R$

2. **Resistor Voltage (V) vs. Time (S) Characteristic Curve**:

- The curve typically shows an exponential rise in voltage across the capacitor as it charges over time.
- (I can't draw here, but you can sketch a graph with time on the x-axis and voltage on the y-axis, showing a curve that starts at zero and asymptotically approaches the supply voltage.)

3. **Electrical Instruments to Measure Current**:

- **Ammeter**: Used for measuring current in a circuit.
- **Clamp Meter**: Measures current without needing to disconnect the circuit.

4. **Current Calculation**: I=Qt=240 C2×60 s=2 A$I=tQ$=2×60s240C=2A

5. **SI Units**: SI units stand for **Système International d'Unités**.

6. **Power Dissipated by a Resistor**: P=I2×R=(2 A)2×10 Ω=40 W$P=I2\times R$=(2A)2×10Ω=40W

7. **Energy Consumed by the Resistor**:
   E=P×t=(I2×R)×t=(2 A)2×100 Ω×(10×3600 s)=1440000 J=1440 kJ*E*=*P*×*t*=(*I*2×*R*)×*t*=(2A)2×100 Ω×(10×3600s)=1440000J=1440kJ

8. **Major Components of a Solar PV System**:

- Solar Panels (Photovoltaic Modules)
- Inverter
- Charge Controller
- Battery Storage System

9. **Current Calculation for Each Resistor**:

- a) I=50V22 Ω≈2.27 A*I*=22Ω50*V*≈2.27A
- b) I=50V820 Ω≈0.061 A*I*=820Ω50*V*≈0.061A
- c) I=50V330,000 Ω≈0.000152 A*I*=330,000Ω50*V*≈0.000152A

10. **Ways to Interconnect Phases**:

- **Star Connection**: Reduces the number of conductors by using a common neutral.
- **Delta Connection**: Allows for three-phase loads to be connected with fewer conductors.

11. **Phase and Line Currents and Voltages in Star Connection**:

- VL=3×VP*VL*=3×*VP*
- IL=IP*IL*=*IP*

12. **Methods to Measure Power in a Three-Phase System**:

- **Wattmeter Method**
- **Two-Wattmeter Method**
- **Three-Wattmeter Method**

13. **Definitions Related to Fuses**:

- a) **Current Rating of a Fuse**: The maximum current that a fuse can carry without blowing.
- b) **Fusing Current**: The current at which the fuse element melts, causing the fuse to blow.

14. **Norton's Theorem**: To determine the current flowing through the 5Ω resistor, you would need the circuit diagram to apply Norton's theorem, which involves finding the equivalent current source and parallel resistance.

SECTION B (60 MARKS)

15. a) i. **Causes of Low Power Factor**:

- Inductive loads (e.g., motors, transformers).

- Capacitive loads (e.g., capacitor banks).

ii. **Ways to Improve Power Factor**:

- Installing power factor correction capacitors.
- Using synchronous condensers.

b) **Calculating Current at Each Power Factor**:

- i. I=PV×PF=1840 W230 V×1≈8 A*I*=*V*×*PFP*=230V×11840W≈8A
- ii. I=1840 W230 V×0.8≈10 A*I*=230V×0.81840W≈10A
- iii. I=1840 W230 V×0.4≈20 A*I*=230V×0.41840W≈20A

iv. **Justification**: As power factor decreases, the current increases for the same power level, indicating less efficiency.

16. a) i. **Reasons for Earthing**:

- Safety from electric shock.
- Protection of equipment from lightning.
- Stabilizing voltage levels.

ii. **Methods of Achieving Earthing**:

- Rod Earthing.
- Plate Earthing.
- Strip Earthing.

iii. **Tests Related to Earthing**:

- Earth Resistance Test.
- Earth Continuity Test.

iv. **Components of Lightning Protection System**:

- Air Termination Rods.
- Down Conductors.
- Earth Termination System.

17. a) **Diagram of a DC Machine**: (You will need to draw a labeled diagram showing stator, rotor, commutator, brushes, etc.)

b) **Single-Phase Capacitor Start Motors**: (You will need to draw a labeled diagram and explain the role of the capacitor in starting the motor and its phasor representation.)

c) **Transformer Losses**: i. **Copper Losses**: Losses due to resistance in the winding when current flows (I^2R losses). ii. **Iron Losses**: Losses due to hysteresis and eddy currents in the core.

18. a) **Average Rate of Cooling**:

- Calculate the total heat absorbed by the ice using specific heat and latent heat, then divide by time to find kJ/hr and TR.

  b) **Refrigeration Effect and COP**:

- Calculate the refrigeration effect using the latent heat and mass flow rate, then find TR and COP based on energy consumed.