Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

COMPUTER POWER SYSTEM DEVELOPMENT

CSAPS501

Develop Computer Power System

Competence

RQF Level: 5

Learning Hours 100

Credits: 10

Sector: ICT AND MULTIMEDIA

Trade: COMPUTER SYSTEM AND ARCHITECTURE

Module Type: Specific

Curriculum: ICTCSA5001-TVET CERTIFICATE V IN COMPUTER SYSTEMS AND ARCHITECTURE

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<table>
<tr><td>Purpose statement</td><td colspan="5">This specific module describes the skills, knowledge, and attitude required to develop computer power system. Upon completion of this module, the learners will be able to prepare the working environment, implement power electronic converters, implement a power supply unit of a computer system and implement computer power management system.</td></tr>
<tr><td>Learning assumed to be in place</td><td colspan="5">N/A</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>30%</td><td rowspan="4">Formative assessment</td><td>30%</td><td rowspan="4">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">70%</td><td rowspan="3">70%</td></tr>
<tr><td>Group project and presentation</td><td>30%</td></tr>
<tr><td>Individual project /Work</td><td>40%</td></tr>
<tr><td colspan="2"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
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Elements of Competence and Performance Criteria	
Elements of competence	**Performance criteria**
1. Prepare the working environment	1.1. Computer system power requirement are analyzed based on its application
	1.2. System power consumption is properly calculated based on used components power ratings.
	1.3. Tools, Equipment and materials are properly selected based on system requirements
2. Implement power electronic converters	2.1. Power electronic converters is correctly designed based on the type of power electronic converters and its application
	2.2. Power electronic converter components are properly assembled based on schematic diagram
	2.3. Power electronic converter is successfully tested according to expected output.
3. Implement a Power Supply Unit (PSU) of a computer system	3.1. Computer power distribution system is correctly designed according to system power requirements
	3.2. Power supply unit are properly assembled in line with Computer power distribution system design
	3.3. Power supply unit is systematically tested according to expected output.
4. Implement computer power management system	4.1. Computer power management system architecture is properly designed based on the computer power system requirements
	4.2. Computer power backup is well designed based on the computer

	power system architecture
	4.3. Power Backup system is correctly integrated onto the existing power system
	4.4. Maintenance measures are correctly applied based on power backup structure.
	4.5. Power system cost is properly estimated according to the power system design

Knowledge, Skills, and Attitude		
Knowledge	**Skills**	**Attitude**
• Description of computer power distribution system • Identification of issues in a power system • Description of electrical principles and knowledge • Description of converters, inverters and power supplies • Description of battery technology and energy storage system	• Selecting tools, materials and equipment • Calculating the computer power system requirements • Resolving issues in a power system • Designing and develop a computer power system model • Designing and analyse power distributing • Test and validate a computer power system • Installation of power management system software • Document technical issues • Design a power backup system for a computer system • Integrating a power backup system into a computer system • Elaboration of a cost estimation	• Willingness to explore new ideas • Demonstrate team spirit while working with others. • Have attention to details. • Being rapid • Take responsibility. • Being organized. • Establish resilience in your daily activities.

Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Prepare the working environment 2. Implement power electronic converters 3. Implement a Power Supply Unit (PSU) of a computer system 4. Implement computer power management system
Learning outcome 1: Prepare the working environment	**Learning hours: 15 hours**

Indicative content

- **Introduction to computer power system**
  - ✓ Definition of key concepts
    - Uninterruptible Power Supply
    - Power management
    - Efficiency
    - Ripple voltage and current
    - Harmonic Distortion
    - Battery management system(BMS)
    - Power converter
  - ✓ Description of computer power supply
    - Types
    - Block diagram
    - Features
    - Advantages and disadvantages
  - ✓ Working principle of computer power system
    - Power conversion

- Power distribution system

- **Analyzing computer system power requirement**
  - ✓ Identification of computer system parts' power consumption
    - Computer system parts
    - Idle mode
    - Sleep mode
    - Under maximum load power rating
  - ✓ Drawing a computer power system architecture
    - Understand power flow
    - Draw lines to components
  - ✓ Analysis of Power Supply Unit (PSU) features
    - Efficiency consideration
    - Expansion and upgrades
    - Verify compatibility
    - Form factor
    - Environmental impact
    - Safety margins
    - Budget and cost considerations

- **Calculation of System Power consumption**
  - ✓ Components power consumption
  - ✓ Efficiency
  - ✓ Total harmonic distortion
  - ✓ Power fluctuations
- **Selection of tools, materials and equipment**
  - ✓ Tools
  - ✓ Materials
  - ✓ Equipment

Resources required for the indicative content	
Equipment	• Personal Computer • PPEs • Oscilloscope • Multi-meter • Function generator • SMD rework station • DC Power supply • ESD workstation • Office UPS
Materials	• Isopropyl alcohol and cotton swabs • Electrical tapes and zip ties • Spare screws • Labeling materials • Connectors • Foam cleaner • Battery/cells • Jumper wires • Breadboard • PCB • Power cables • Glue stick • Drawing materials (papers and pencil)
Tools	• Screwdrivers • Needle-nose pliers • Universal plier

	• Tweezers • Flashlight or headlamp • Cable testers • ESD Tools applicator • Wire cutter/striper Pliers • Soldering iron • Desoldering pump • Glue gun • Circuit Simulation and drawing software (NI Multisim, Proteus, Autodesk Eagle, Easy EDA, matlab, CAD) • Drawing accessories
Facilitation techniques	• Demonstration • Individual and group work • Practical exercise • Trainer guided • Group discussion
Formative assessment methods	• Product assessment • Written assessment • Performance assessment • Oral presentation

Learning outcome 2: Implement power electronic converters	Learning hours: 35 hours

Indicative content

- **Designing power electronic converters**
  - ✓ Description of Power semiconductor devices
    - component symbols
    - Working principles
    - Power rating
    - Applications of power semiconductor devices
  - ✓ Description of power converter
    - AC to DC converter
    - DC to AC converter
    - DC to DC converter
    - AC to AC converter
  - ✓ Installation of simulation software
  - ✓ Drawing of power converters circuit diagrams
  - ✓ Simulating the power converter
    - AC to DC converter
    - DC to AC converter
    - DC to DC converter
    - AC to AC converter
  - ✓ Generate power converter PCB Design
- **Assembling power electronic converter components**
  - ✓ Placing components into PCB
  - ✓ Soldering the components
  - ✓ Wiring and connection of components
- **Testing power electronic converters**

- ✓ Continuity testing
- ✓ Measure voltage and current
- ✓ Analyze output waveform

Resources required for the indicative content	
Equipment	• Personal Computer • PPEs • Oscilloscope • Multi-meter • Function generator • SMD rework station • Drawing table • DC Power supply • ESD workstation • Office UPS
Materials	• Isopropyl alcohol and cotton swabs • Electrical tapes and zip ties • Spare screws • Labeling materials • Connectors • Foam cleaner • Battery/cells • Jumper wires • Breadboard • PCB

	• Power Semiconductor devices • Soldering materials • Power cables • Glue stick • Drawing materials (papers and pencil) • Electronic Passive Components
Tools	• Screwdrivers • Needle-nose pliers • Universal plier • Tweezers • Flashlight or headlamp • Cable testers • Wire cutter/striper Pliers • Soldering iron • Desoldering pump • Glue gun • Circuit Simulation and drawing software (NI Multisim, Proteus, Autodesk Eagle, Easy EDA, matlab, CAD) • Drawing accessories
Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion
Formative assessment methods	• Product assessment • Written assessment

	• Performance assessment • Oral presentation

Learning outcome 3: Implement a Power Supply Unit (PSU) of a computer system	**Learning hours: 20 hours**

Indicative content

- **Designing computer power distribution system**
  - ✓ Interpreting voltage regulation
    - Voltage divider circuit
    - Voltage rails
    - Automatic voltage regulator
    - Voltage regulator module
  - ✓ Designing a power distribution scheme
- **Assembling power supply unit**
  - ✓ Description of a power supply types
    - Linear power supply
    - Switched-Mode Power Supply (SMPS)
    - Uninterruptible Power Supply (UPS)
    - Programmable power supply
    - Variable power supply
  - ✓ Drawing of schematic diagram of power supply unit
  - ✓ Simulating the power supply unit circuit diagrams
    - Linear power supply
    - Switched-Mode Power Supply (SMPS)
    - Uninterruptible Power Supply (UPS)
    - Programmable power supply
    - Variable power supply

- ✓ Generate power supply PCB
- ✓ Assembling power supply unit

- **Testing computer supply unit**
  - ✓ Visual inspection
  - ✓ Input voltage and current measurement
  - ✓ Output voltage and current measurement
  - ✓ Transient response
  - ✓ Ripple measurement
  - ✓ Overload and short circuit protection
  - ✓ Temperature test
  - ✓ EMI/EMC testing
  - ✓ Safety testing

Resources required for the indicative content	
Equipment	• Personal Computer, • PPEs, • Oscilloscope, • Multi-meter, • Function generator, • ESD Workbench, • SMD rework station, • Blower, • DC Power supply,

Materials	• Isopropyl alcohol and cotton swabs • Electrical tapes and zip ties • Spare screws • Labeling materials • Connectors • Foam cleaner • Battery/cells • Jumper wires • Breadboard • PCB • Power Semiconductor devices • Soldering materials • Power cables • Glue stick • Drawing materials (papers and pencil) • Electronic Passive Components
Tools	• Screwdrivers • Needle-nose pliers • Universal plier • Tweezers • Flashlight or headlamp • Cable testers • ESD Tools applicator • Wire cutter/striper Pliers • Soldering iron • Desoldering pump • Glue gun • Circuit Simulation and drawing software (NI Multisim, Proteus, Autodesk Eagle, Easy EDA, matlab, CAD)

	• Drawing accessories
Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion
Formative assessment methods	• Product assessment • Written assessment • Performance assessment • Oral presentation

Learning outcome 4: Implement power management system	**Learning hours: 30 hours**
Indicative content	

- **Designing computer power management system architecture**
  - ✓ Assessment and requirements gathering
    - Evaluate power requirements and usage pattern
    - Identify critical components
    - Document findings and requirements
  - ✓ Identify computer power management techniques
    - Sleep modes
    - Processor power states
    - Software optimization
  - ✓ Identify Power Saving Strategies

- Dynamic voltage and frequency scaling (DVFS)
- Smart power Management Policies

✓ Describe battery management system

- Battery
- Monitoring battery health and status
- Managing charge/discharge cycles
- Optimizing charging efficiency

✓ Selection of tools and technologies

- Hardware components
- Software
- Integration and compatibility

✓ Develop computer power management plan

- Initial assessment and planning
- Development of power management policies and profiles

- **Designing power backup system components**

✓ Description of power backup

- Definition
- Types
- Protection
- Power backup technology

✓ Calculating power backup size

- Backup time
- Total power delivered by back up
- Total power consumption by system

✓ Identify backup power sources

- UPS
- Lithium battery bank
- Redundant power supply

✓ Build battery charging system

- Apply charging method

- Setting charging profile
- Design charging controller
- Testing efficiency and power factor
- Managing temperature
- Monitoring and control of batteries

- **Integration of power backup system components**
  - ✓ Compatibility Assessment
    - Voltage compatibility
    - Communication protocols
    - Physical dimensions
    - Power ratings and capacities
    - Environmental compatibility
  - ✓ Assess component placement considerations
    - Space utilization
    - Cable management
    - Heat dissipation
    - Weight distribution
    - Future expansion and scalability
  - ✓ Install electrical power backup
    - Connector compatibility
    - Wire routing
    - Wire termination
    - Protection devices
    - Grounding
  - ✓ Apply communication interface
    - Identify communication needs
    - Select communication protocols
    - Interface configuration
    - Battery Management System (BMS) integration
  - ✓ Integration of power backup to power supply unit

- Compatibility assessment
- Design considerations
- Electrical connections
- Communication interface
- Testing

- **Maintaining power backup**
  - ✓ Implement monitoring capabilities
    - Selection of monitoring tools
    - Integration of monitoring software
  - ✓ Establish routine maintenance procedures
    - Scheduled inspection
    - Battery maintenance
    - Safety precautions sticker
    - Cleaning and housekeeping
    - Documentation and record-keeping
    - Training and personnel development
- **Estimation of power system cost**
  - ✓ Description of cost estimation
    - Definition
    - Model of cost estimation
    - Types of cost estimates
  - ✓ Description of bill of quantity
    - Definition
    - Content
  - ✓ Design bill of quantity
  - ✓ Applying cost estimation
    - Develop cost estimation plan
    - Sensitivity analysis
    - Design cost estimation report

Resources required for the indicative content	
Equipment	• Personal Computer • PPEs • Oscilloscope • Multi-meter • Function generator • SMD rework station, • DC Power supply • Office UPS
Materials	

	• Soldering wire • Jumper wires • Breadboard • PCB • Power cables • Desoldering wick • Drawing materials (papers and pencil) • Electronic Passive Components

Tools	• Screwdrivers • Needle-nose pliers • Universal plier • Tweezers • Flashlight or headlamp • Cable testers • ESD Tools applicator • Wire cutter/striper Pliers • Soldering iron • Desoldering pump • Glue gun • Circuit Simulation and drawing software (NI Multisim, Proteus, Autodesk Eagle, Easy EDA, matlab, CAD) • Drawing accessories
Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion
Formative assessment methods	• Product assessment • Written assessment • Performance assessment • Oral presentation

Integrated/Summative assessment

WWBXX COMPUTER Limited is a new computer manufacturing company located in MASORO Special Economic Zone. It aims at solving battery power saving problems of the computers on the market nowadays. Such as fluctuating power from adapters delivered to the system and power, saving problems that includes inaccurate battery indicators and overheating of laptop batteries.

As a technician, you are hired to develop a laptop power system of 19V DC, 80W and 3 hours power saving time, and determine power supply efficiency, optimal battery capacity, select suitable battery types and configurations, implementing rigorous safety measures, and evaluating portability for practical usage scenarios.

TASK

1. Preparing a cost estimate
2. Design a laptop adapter
3. Design a laptop backup power system
4. Integrate the power backup system into the laptop

Instruction:

1. Prepare clear and concise documentation explaining how to use and maintain the device.
2. This work must be done within 10 hours.

Information

Tools, materials, and equipment are provided.

RESSOURCES

Equipment	• Personal Computer • PPEs • Oscilloscope • Multi-meter

	• Function generator • SMD rework station, • Drawing table • DC Power supply • Office UPS
Tools	• Screwdrivers • Needle-nose pliers • Universal plier • Tweezers • Flashlight or headlamp • Cable testers • ESD Tools applicator • Wire cutter/striper Pliers • Soldering iron • Desoldering pump • Glue gun • Circuit Simulation and drawing software (NI Multisim, Proteus, Autodesk Eagle, Easy EDA, Matlab, CAD) • Drawing accessories
Materials	• Anti-static wrist strap/mat • Soldering wire (tin) • Soldering paste • Isopropyl alcohol and cotton swabs • Electrical tapes and zip ties, • Spare screws • Labeling materials • Connectors,

	• LM338, BC547, ICR 18650 2000mah 3.7V Li-ion cells • Resistor(120 Ω, 1kω, etc) • Potentiometer(4k7, 1k, 10k) • 100µf 25V capacitor • LM78XX • Diodes • Transformer • Fuse • Rectifier • Electronic relay • Glue stick • Foam cleaner • Soldering paste • Desoldering wire (desoldering wick) • Soldering wire • Jumper wires • Breadboard • PCB • Power cables • Drawing materials (papers and pencil).

Assessable outcomes	Assessment criteria (Based on performance Criteria)	Indicator	Observation		Marks Allocation
			Yes	No	
1. Prepare the working environment (15%)	Computer system power requirement are analyzed based on its application	Computer system parts are identified			2
		Computer system parts' power consumption are identified			1
		Computer power system architecture are drawn			1
	System Power consumption is properly calculated based on used components power ratings	Component power consumption are calculated			2
		Efficiency are calculated			2
		Total harmonic distortion are calculated			2
		Power fluctuations			2

	Tools, Equipment and materials are properly selected based on system requirements	Tools are selected			1
		Equipment are selected			1
		Materials are selected			1
2. Implement power electronic converters (35%)	Power electronic converters is correctly designed based on the type of power electronic converters and its application	Power semiconductor devices are described			3
		Power converter Are described			3
		Simulation software are installed			3
		Power converters circuit diagrams are drawn			3
		Power converter circuit diagram are simulated			3
		Power converter PCB design are generated			4
	Power electronic converter components are properly assembled based on schematic diagram	Components are placed into PCB			3
		Components are soldered			3

		Components are connected			3
		Power supply PCB are generated			3
		Power supply unit are assembled			4
	Power electronic converter is successfully tested according to expected output.	Power electronic converters are tested			3
3. Implement a Power Supply Unit (PSU) of a computer system (20%)	Computer power distribution system is correctly designed according to system power requirements	Voltage regulation are interpreted			4
		Power distribution scheme are designed			4
	Power supply unit are properly assembled in line with Computer power distribution system design	Power supply types are described			3
		Schematic diagram of power supply unit are drawn			3
		Power supply unit circuit diagrams are simulated			3
	Power supply unit is systematically tested according to expected output.	Computer Supply unit are Tested			3

4. Implement computer power management system (30%)	Computer power management system architecture is properly designed based on the computer power system requirements	Requirements gathering are Assessed			1
		Computer power management techniques are identified			1
		Power Saving strategies are identified			1
		Battery management system are described			1
		Backup tools and technologies are selected			1
		Computer power management plan are developed			1
	Computer power backup is well designed based on the computer power system architecture	Power backup size are calculated			2
		Backup power sources are identified			2
		Battery charging system are built			2

	Power Backup system is correctly integrated onto the existing power system	Compatibility are assessed			2
		Component placement considerations are assessed			2
		Electrical power backup are installed			2
		Communication interface are applied			2
		Power backup to power supply unit are integrated			2
	Maintenance measures are well applied based on power backup structure.	Monitoring capabilities are implemented			2
		Routine maintenance procedures are established			2
	Power system cost is properly estimated according to the power system design	BOQ is designed			2
		Cost estimation are applied			2
Total marks					**/100**
Percentage Weightage					**/100%**
Minimum Passing line % (Aggregate): 70%					

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Glossary

- **Power Supply Unit (PSU)**: A hardware component that provides electrical power to a computer or other devices.
- **Wattage**: The measure of electrical power a PSU can deliver to the components in a system, typically measured in watts (W).
- **Efficiency**: The ratio of output power to input power, expressed as a percentage. A higher efficiency PSU wastes less power as heat.
- **Voltage**: The electrical potential difference between two points, typically measured in volts (V). PSUs provide different voltages (e.g., +12V, +5V, +3.3V) to different components.
- **Current**: The flow of electric charge, typically measured in amperes (A). PSUs supply different currents to different components based on their power requirements.

- **Direct Current (DC)**: An electrical current that flows in one direction, which is what PSUs provide to the components in a computer.
- **Alternating Current (AC)**: An electrical current that changes direction periodically, which is typically what is supplied by power outlets.

Abbreviations

- **PPEs**: Personal Protective Equipment
- **ESD**: Electrostatic Discharge
- **PSU:** Power Supply Unit
- **UPS:** Uninterruptable Power Supply
- **SPS:** Switching Power Supply
- **EMI:** Electromagnetic Interference
- **EMC:** Electromagnetic Compatibility
- **CAD:** Computer Aided Design
- **DC:** Direct Current
- **AC:** Alternating Current