



Republic of Rwanda  
Ministry of Education



RTB | RWANDA  
TVET BOARD

**CSACH501**

## COMPUTER HARDWARE ARCHITECTURE

Design Computer Hardware Architecture  
Competence

RQF Level: 5

Learning Hours



Credits: 10

Sector: ICT AND MULTIMEDIA

Trade: COMPUTER SYSTEM AND ARCHITECTURE

Module Type: Specific

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

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<b>Purpose statement</b>	This specific module describes the skills, knowledge and attitude required to design computer hardware architecture. This module is intended to prepare learners pursuing TVET Level 5 in Computer System and Architecture. Upon completion of this module, the learner will be able to prepare design environment, design computer hardware modules and produce computer hardware architecture.					
<b>Learning assumed to be in place</b>	N/A					
<b>Delivery modality</b>	<b>Training delivery</b>		<b>100%</b>	<b>Assessment</b>		
	<b>Theoretical content</b>		<b>30%</b>	<b>Formative assessment</b>	<b>30%</b>	
	<b>Practical work:</b>		<b>70%</b>		<b>50%</b>	
	Group project and presentation	<b>20%</b>				
	Individual project /Work	<b>50%</b>				
			<b>Summative Assessment</b>		<b>50%</b>	

### Elements of Competence and Performance Criteria

<b>Elements of competence</b>	<b>Performance criteria</b>
1. <b>Prepare design environment</b>	1.1. Computer hardware architecture is properly analyzed based on user needs. 1.2. Tools are appropriately selected based on hardware requirements 1.3. Software tools are properly installed in line with the software manual.
2. <b>Design Computer hardware Modules</b>	2.1. Conceptual model of computer hardware architecture is neatly drawn based on hardware requirements 2.2. Modules Schematic diagrams are neatly drawn based on hardware requirements and 2.3. Individual module is properly simulated based on the schematic diagram and its functionality
3. <b>Produce computer hardware architecture.</b>	3.1. Modules are correctly interconnected based on instruction set architecture (ISA) and conceptual model. 3.2. The computer hardware architecture blueprint is properly created based on a schematic diagram 3.3. Computer hardware architecture design is properly documented based on work done.

Knowledges	Skills	Attitude
<ul style="list-style-type: none"> <li>• Identification Computer system components</li> <li>• Description digital logics</li> <li>• Description electricity concepts</li> <li>• Description mathematical analysis</li> <li>• Description conceptual model</li> <li>• Description schematic diagrams</li> <li>• Description system architecture blueprints</li> </ul>	<ul style="list-style-type: none"> <li>• Installation of application software</li> <li>• Interpretation of conceptual diagram</li> <li>• Modeling conceptual models</li> <li>• Modeling schematic diagrams</li> <li>• Analyzing schematic diagrams</li> <li>• Simulating models</li> <li>• Documentation skills</li> </ul>	<ul style="list-style-type: none"> <li>• Continuous Improvement and Learning</li> <li>• Being organized</li> <li>• Having self-learner spirit</li> <li>• Having team work spirit</li> <li>• Being patient</li> <li>• Having critical thinking</li> <li>• Being a quick learner</li> <li>• Being hard working</li> <li>• Self-motivated</li> <li>• Having persistence</li> <li>• Having team work</li> <li>• Having time management</li> <li>• Having reasoning</li> <li>• Being honest</li> <li>• Having accountability</li> <li>• Being decisive making</li> <li>• Having creativeness</li> <li>• Being patient</li> <li>• Being innovative</li> <li>• Having integrity</li> <li>• Being goal oriented</li> <li>• Having self-confidence</li> <li>• Having task management</li> <li>• Being energetic</li> <li>• Being Personal worker</li> <li>• Having strong moral character</li> <li>• Having personal hygiene/grooming</li> <li>• Being open minded</li> </ul>

## Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Prepare design environment
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	2. Design computer hardware modules 3. Produce computer hardware architecture
<b>Learning outcome 1: Prepare design environment</b>	<b>Learning hours: 20</b>
<b>Indicative content</b>	
<ul style="list-style-type: none"> <li>• <b>Analyzing computer hardware architecture</b> <ul style="list-style-type: none"> <li>✓ Introduction to computer hardware           <ul style="list-style-type: none"> <li>⊕ Definition</li> <li>⊕ Components</li> <li>⊕ Hierarchy Levels</li> <li>⊕ Abstraction layers</li> </ul> </li> <li>✓ Description of Computer Hardware Architecture           <ul style="list-style-type: none"> <li>⊕ Definition</li> <li>⊕ Components</li> <li>⊕ Types</li> <li>⊕ Levels</li> </ul> </li> <li>✓ Analysis of computer hardware architecture requirements           <ul style="list-style-type: none"> <li>⊕ Functionality</li> <li>⊕ Performance</li> <li>⊕ Scalability</li> <li>⊕ Security</li> <li>⊕ Cost</li> <li>⊕ Power consumption</li> <li>⊕ Standards</li> </ul> </li> <li>✓ Produce hardware Requirements Specifications</li> </ul> </li> <li>• <b>Selection of tools</b> <ul style="list-style-type: none"> <li>✓ CAD tools           <ul style="list-style-type: none"> <li>⊕ Types</li> <li>⊕ Application</li> <li>⊕ Selection criteria</li> </ul> </li> <li>✓ Drawing and Documentation tools           <ul style="list-style-type: none"> <li>⊕ Types</li> <li>⊕ Application</li> <li>⊕ Selection criteria</li> </ul> </li> <li>✓ Simulation Tools           <ul style="list-style-type: none"> <li>⊕ Types</li> <li>⊕ Application</li> <li>⊕ Selection criteria</li> </ul> </li> </ul> </li> <li>• <b>Installation of software tools</b> <ul style="list-style-type: none"> <li>✓ Installing drawing tool (EDrawMax)</li> <li>✓ Installing simulation tool (Proteus)</li> <li>✓ Integrate libraries           <ul style="list-style-type: none"> <li>⊕ Identify needed library</li> <li>⊕ Install library</li> </ul> </li> </ul> </li> </ul>	

⊕ Test library integration

Resources required for the learning outcome

<b>Equipment</b>	<ul style="list-style-type: none"> <li>• Laptops</li> </ul>
<b>Materials</b>	<ul style="list-style-type: none"> <li>• Electricity, Internet</li> </ul>
<b>Tools</b>	<ul style="list-style-type: none"> <li>• CAD Software</li> <li>• Draw.io</li> <li>• VMware</li> <li>• Virtual box</li> <li>• Microsoft Visio</li> <li>• Simulink</li> <li>• Spice</li> <li>• EasyEDA</li> </ul>
<b>Facilitation techniques or Learning activity</b>	<ul style="list-style-type: none"> <li>• Demonstration</li> <li>• Individual and group work</li> <li>• Practical exercise</li> <li>• Group discussion</li> </ul>
<b>Formative assessment methods / (CAT)</b>	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral presentation</li> <li>• Practical Assessments</li> </ul>

<b>Learning outcome 2: Design Computer hardware Modules</b>	<b>Learning hours: 50</b>
<b>Indicative content</b>	
<ul style="list-style-type: none"> <li>• <b>Drawing Conceptual model of computer hardware architecture</b> <ul style="list-style-type: none"> <li>✓ Introduction to conceptual modeling <ul style="list-style-type: none"> <li>⊕ Definition</li> <li>⊕ Types</li> <li>⊕ Core components/elements</li> <li>⊕ Symbols and notations</li> <li>⊕ Guidelines</li> <li>⊕ Benefits</li> </ul> </li> <li>✓ Developing conceptual model <ul style="list-style-type: none"> <li>⊕ Define Scope</li> <li>⊕ Identify Components and modules</li> <li>⊕ Create conceptual model</li> </ul> </li> </ul> </li> <li>• <b>Drawing schematic diagrams of modules</b> <ul style="list-style-type: none"> <li>✓ Description of schematic diagrams of modules <ul style="list-style-type: none"> <li>⊕ Definition</li> <li>⊕ Types of computer hardware architecture modules</li> </ul> </li> </ul> </li> </ul>	

- Components' symbols
- ✓ Develop Schematic diagram of each individual module
  - Components placement
  - Components layout
  - Components line of connection
  - Labels and Annotations
  - Signal path
  - Title block
- ✓ Review and refine
  - Feedback interpretation
  - Design rule check
- **Simulation of individual module**
  - ✓ Set components property
    - Set optional parameters
    - Set program file path
  - ✓ Add power source
  - ✓ Configure simulation settings
  - ✓ Run simulation
  - ✓ Analyses simulation result

#### Resources required for the indicative content

<b>Equipment</b>	<ul style="list-style-type: none"> <li>• Laptop</li> </ul>
<b>Materials</b>	<ul style="list-style-type: none"> <li>• Electricity</li> </ul>
<b>Tools</b>	<ul style="list-style-type: none"> <li>• CAD Software</li> <li>• Draw.io</li> <li>• Simulink</li> <li>• Proteus</li> <li>• Solidwork</li> </ul>
<b>Facilitation techniques or Learning activity</b>	<ul style="list-style-type: none"> <li>• Demonstration</li> <li>• Individual and group work</li> <li>• Practical exercise</li> <li>• Group discussion</li> </ul>
<b>Formative assessment methods /(CAT)</b>	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral presentation</li> <li>• Practical Assessments</li> </ul>

<b>Learning outcome 3: Produce computer hardware architecture.</b>	<b>Learning hours: 30</b>
<b>Indicative content</b>	
<ul style="list-style-type: none"> <li>• <b>Introduction to interconnection structure</b> <ul style="list-style-type: none"> <li>✓ Definition of key terms           <ul style="list-style-type: none"> <li>▪ Interconnection structure</li> <li>▪ Module interface</li> <li>▪ Bus</li> </ul> </li> </ul> </li> </ul>	

- Instruction Set Architecture
- ✓ Types of interconnection structure
  - Bus architecture
  - interconnection network (Point-to-point)
  - Hybrid approaches
- ✓ Types of transfer
  - Memory to processor
  - Processor to memory
  - I/O to processor
  - Processor to I/O
  - I/O to or from memory
- **Interconnecting modules**
  - ✓ Determine module-to-module communication needs
    - Data and control signals
    - Communication frequency
  - ✓ Selecting interconnection structure
  - ✓ Implement interconnection structure
  - ✓ Configure module-to-module interconnection
    - Communication protocols
    - Standard for data exchange protocols
  - ✓ Simulating computer hardware architecture
- **Creating a computer hardware architecture blueprint**
  - ✓ Introduction to Blueprint
    - Definition
    - Objectives
  - ✓ Convert schematic diagram to blueprint
  - ✓ Export blueprint
  - ✓ Validate blueprint
- **Documenting computer hardware architecture design**
  - ✓ Identify Elements of hardware architecture documentation
    - Architecture principle
    - Components and their responsibilities
    - Technologies and Tools
    - Security considerations,
    - Communication architecture
  - ✓ Produce Computer hardware technical document

#### Resources required for the indicative content

<b>Equipment</b>	<ul style="list-style-type: none"> <li>• Laptops</li> </ul>
<b>Materials</b>	<ul style="list-style-type: none"> <li>• Electricity</li> </ul>
<b>Tools</b>	<ul style="list-style-type: none"> <li>• CAD Software</li> <li>• Draw.io</li> <li>• Matlab</li> <li>• Simulink</li> </ul>

	<ul style="list-style-type: none"> <li>• Proteus</li> <li>• solidwork</li> <li>• Proteus</li> </ul>
<b>Facilitation techniques or Learning activity</b>	<ul style="list-style-type: none"> <li>• Demonstration (Guided practice)</li> <li>• Individual and group work</li> <li>• Practical exercise</li> <li>• Group discussion</li> </ul>
<b>Formative assessment methods /(CAT)</b>	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral presentation</li> <li>• Practical Assessments</li> </ul>

### Integrated/Summative assessment (For specific module)

XYZ Ltd is a microcomputer-based company located in Rwanda. They have been making and selling these microcomputers for over 3 years. They have been using imported motherboards in their production leading to high production costs and selling prices, hence attracting few customers.

They want to reduce production costs by building their own microcomputer motherboard and stop relying on imports.

To achieve this, XYZ Ltd has hired you as a computer hardware architect to design a simple prototype of a microcomputer with these specifications:

- 16-bit Processor
- 2 KB RAM
- 8 KB ROM
- 2 USB Data Ports
- HDMI Port
- Ethernet Port
- SD Card Push-Pull slot
- Audio jacks
- Power port

Additionally, you are required to design a mouse and a keyboard architecture apart.

Task:

1. Create the new microcomputer blueprint
2. Document the microcomputer architecture design

Instructions:

1. A conceptual model of the microcomputer architecture must be drawn
2. Schematic diagrams of individual modules must be drawn
3. Individual modules must be simulated

This work must be done within 10 hours

Tools, materials, and equipment should be provided.					
Resources					
<b>Tools</b>		<ul style="list-style-type: none"> <li>• CAD Software</li> <li>• Draw.io</li> <li>• Matlab</li> <li>• Simulink</li> <li>• Proteus</li> <li>• Solid work</li> </ul>			
<b>Equipment</b>		<ul style="list-style-type: none"> <li>• Laptop</li> <li>• computer</li> </ul>			
<b>Materials/ Consumables</b>		<ul style="list-style-type: none"> <li>• Electricity</li> <li>• internet</li> </ul>			
Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation	Marks allocation	
Learning outcome 1: Prepare design environment (30%)	<b>Tools are appropriately selected</b>  <b>Software tools are properly installed</b>	Designing tool is selected  Simulation tool is selected  Blueprint modeling tool is selected  Designing tool is installed  Simulation tool is installed  appropriate libraries are integrated	Yes  No	1  1  1  1  1  2	
Learning outcome 2: Design computer hardware modules (40%)	<b>Conceptual model of computer hardware architecture is drawn</b>  <b>Modules Schematic diagrams are Properly drawn</b>  <b>Individual module's simulation produces expected results</b>	Scopes are defined  Modules are identified  Components are identified  Conceptual model is drawn  Components are placed for each module  Signals path are drawn in each module  Labels and annotations are added in each module  Title block is added in each module  Design Rules are followed  Components properties are set  Simulation settings are configured		3  4  3  5  10  10  3  3  2  4  3	

		Simulation works as expected		3
Learning outcome 3: Produce computer hardware architecture (30%)	<b>Modules are correctly interconnected</b>	Interconnection structure is selected		2
		Interconnection structure is implemented		5
		Module to module interconnections are configured		4
		Simulation of the whole system goes as expected		6
	<b>The computer hardware architecture blueprint is properly created</b>	Schematic diagram is converted to blueprint		5
		Blueprint is exported		7
		Blueprint is valid		5
		System Architecture is documented		6
Total marks				100
<b>Percentage Weightage</b>				100%
<b>Minimum Passing line % (Aggregate): 70%</b>				

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## References:

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