

KWAME NKRUMAH UNIVERSITY OF SCIENCE
AND
TECHNOLOGY, KUMASI, GHANA



TENDER DOCUMENTS - PRICE QUOTATION

PROCUREMENT OF ELECTRONIC HARDWARE
AND NETWORKING EQUIPMENT FOR THE
EMBEDDED SYSTEMS, ROBOTICS, AND
ARTIFICIAL INTELLIGENCE LABORATORY
AT THE DEPARTMENT OF COMPUTER
SCIENCE, KNUST.

IFT NO: AS/KNUST/GD/0060D/2026

AUGUST, 2026

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Introduction and Instructions

This Tender Document, Procurement of Goods – Price Quotation, has been prepared by the Public Procurement Board for use by Procurement Entities in accordance with the Public Procurement Act, 2003 (Act 663) of the Republic of Ghana.

This Standard Form has been developed based on relevant experience in this field.

Section I. Invitation for Sealed Quotation

Name of Procurement Entity: KWAME NKRUMAH UNIVERSITY OF SCIENCE & TECHNOLOGY, KUMASI

Address of Procurement Entity: **Procurement Office, KNUST- Kumasi**

Telephone or telex: **032-2060437**

Email Address: **procurement@knust.edu.gh**

Sealed Quotation No: PQ/08/2026

Date of Invitation: **7th August, 2026**

1. Kwame Nkrumah University of Science and Technology, Kumasi intends to apply part of its Budgetary Allocation to fund eligible payments for this Tender.
2. Kwame Nkrumah University of Science and Technology invites sealed quotations from eligible registered suppliers for the Supply of Electronic Hardware and Networking Equipment to the Embedded Systems, Robotics, and Artificial Intelligence Laboratory at the Department of Computer Science, KNUST.
3. Quotations must be submitted electronically through the Ghana Electronic Procurement System (GHANEPS) **on or before 11:00 a.m. on Friday, 14th August, 2026**. Submissions received after the deadline will not be accepted by the system.
4. Quotations will be opened electronically through the Ghana Electronic Procurement System (GHANEPS) at **11:00 a.m. on Friday, 14th August, 2026** in accordance with the system's electronic tender opening procedures.
5. Tenderers shall complete and upload the Tender Form, Price Schedule, Tender Securing Declaration, and Technical Specifications Table through the Ghana Electronic Procurement System (GHANEPS) as part of their electronic submission.
6. To be eligible to participate in this tender, tenderers must be registered and active on the Ghana Electronic Procurement System (GHANEPS).
7. Tender Validity is **60 days**.
8. The quotations must be signed by the Tenderer. No alternative quotations would be accepted.
9. Notice of Acceptance of Tender shall be sent to you at any time prior to expiration of Tender Validity.
10. Tenderer shall deliver a Performance Security of 10% **(with at least one (1) year validity)** of the Contract sum and in the form of Bank Guarantee or Performance Bond of 30% within 14 days of the receipt of Notice of Acceptance of Tender.

DUKE AGYEMAN FREDUA
(DIRECTOR OF PROCUREMENT)

Section II. Conditions of Contract

- | | |
|-----------------------------------|--|
| 1. Definitions | <p>1.1 In this contract, the following terms shall be interpreted as indicated:</p> <ul style="list-style-type: none"> a. "The Contract" means the agreement entered into between the Purchaser and the Supplier, as recorded in the Contract Form Signed by the parties, including all attachments and appendices thereto and all documents incorporated by reference therein; b. "The Contract Price" means the price payable to the Supplier under the contract for the full and proper performance of its contractual obligation; c. "The Goods" means Equipment and related Accessories and spare-parts which the Supplier is required to supply to the Purchaser under the contract; d. "Services" means services ancillary to the supply of the goods such as transportation and insurance including the installation, commissioning and the operational and maintenance training of the supplied equipment. e. "The Purchaser" means the organization purchasing the goods; f. "The Supplier" means the organization supplying the goods and services under this contract. |
| 2. Technical Specification | <p>2.1 The goods supplied under this contract shall conform to the standards mentioned in the Technical Specification.</p> |
| 3. Patent Right | <p>3.1 The Supplier shall indemnify the Purchaser against all third party claims of infringement of patent, trademark or industrial design rights arising from use of goods or any part thereof in the Purchaser's country.</p> |
| 4. Inspection and Tests | <p>4.1 The Purchaser or its Representative shall have the right to inspect and/or test the goods to confirm their conformity to the Technical Specification and the quality of performance after the supply and delivery of good to Purchaser's premises.</p> |

- | | |
|-----------------------------|--|
| 5. Packing | <p>5.1 The Supplier shall provide such packing of the goods as is required to prevent their damage or deterioration during transit to their final destination as indicated in the contract.</p> <p>5.2 The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit and open storage.</p> <p>5.3 Packing case, size and weights shall take into consideration, where appropriate, the remoteness of the goods' final destination and the absence of heavy handling facilities at all points in transit.</p> <p>5.4 The packing, marking and documentation within and outside the packages shall comply strictly with such special requirements as shall be expressly provided in accordance with international standard and practice.</p> |
| 6. Delivery of Goods | <p>6.1 Delivery of the goods shall be made by the Supplier in accordance with the terms specified by the Purchaser in its schedule of requirements.</p> <p>6.2 For purposes of the contract "FOB", "C&F", "CIF", "CIP" and other trade terms used to describe the obligations of the parties shall have the meanings assigned to them by the current edition of the International Rules for the Interpretation of the Trade Terms (INCOTERMS) published by the International Chamber of Commerce (ICC), Paris.</p> |
| 7. Insurance | <p>7.1 The goods supplied under the contract shall be fully insured in the currency of the bid price against loss or damage incidental to manufacture or acquisition, transportation, storage and delivery in the manner specified.</p> <p>7.2 Where delivery of the goods is required by the Purchaser on a CIF or CIP basis to a specified destination, the Supplier shall arrange and pay for insurance, naming the Purchaser as the Beneficiary and the Supplier shall be required to meet all transport and storage expenses until delivery.</p> |
| 8. Warranty | <p>8.1 The Supplier warrants that all the goods supplied under the contract shall fully comply with the specification laid down in the contract.</p> |

8.2 The warranty shall remain valid for one year after the goods have been delivered to the final destination indicated in the contract, and accepted by the Purchaser after installation and commissioning of equipment by the Supplier.

8.3 The Purchaser shall promptly notify the Supplier in writing of any claims arising under this warranty.

8.4 Upon receipt of such notice, the Supplier shall, within 30 days replace the defective goods without cost to the Purchaser. The Supplier will be required to remove, at its own risk and cost, the defective goods.

9. Payment

9.1 Payment shall be made in the currency in which the contract price has been stated in the Supplier's tender.

9.2 Payment of the goods supplied from within Ghana shall be made in Ghanaian Cedis after the delivery and installation and commissioning of goods to the satisfaction of the Purchaser.

9.3 Payment of the goods supplied shall be made in the following manner:

On acceptance: Hundred (100) percent of the contract price of goods received shall be paid within thirty (30) days of receipt of the goods upon submission of claim supported by the acceptance certificate issued by the Purchaser.

10. Prices

10.1 Prices charged by the Supplier for goods delivered under the contract shall not vary from the prices quoted by the Supplier in its sealed quotation.

11. Liquidated Damages

11.1 If the Supplier fails to deliver any or all of the goods within the time period specified in the contract, the Purchaser shall, without prejudice to its other remedies under the contract, deduct from the contract price, as liquidated damages, a sum equivalent to 1.0 percent of the contract price of delayed goods for each week of delay until actual delivery, up to a maximum deduction of 10 percent of the delayed goods' contract price. Once the maximum is reached, the Purchaser may consider termination of the contract.

12. Resolution of Disputes

12.1 The Purchaser and Supplier shall make every effort to resolve amicably by direct informal negotiation any

disagreement or dispute arising between them under or in connection with the contract.

- 12.2 If, after thirty (30) days from the commencement of such informal negotiation, the Purchaser and Supplier have been unable to resolve amicably a contract dispute, it shall be referred by either party to an adjudicator agreed by the parties. In the event of disagreement, the adjudicator shall be appointed in accordance with the Laws and Rules of Ghana.

13. Governing Language

- 13.1 The Governing Language shall be English

14. Applicable Law

- 14.1 The applicable law shall be the Laws of Ghana.

15. Notices

- 15.1 Purchaser's Address for Notice Purposes:
KNUST PROCUREMENT OFFICE, KUMASI

- 15.2 Supplier's address for notice purposes:

16. Taxes and Duties

- 16.1 The Supplier shall be entirely responsible for all taxes, duties, licence fees and other such levies imposed by the Government of Ghana.

17. Operation, Maintenance and Spare-parts Manuals

- 17.1 The successful Supplier shall supply 2 copies of manufacturer's operation, maintenance and spare-part manuals of the goods (Equipment).

Section III. Form of Contract

THIS AGREEMENT made the _____ day of _____ 20____ between _____ (hereinafter called “the Purchaser”) of the one part and *[name of Supplier]* of *[city and country of Supplier]* (hereinafter called “the Supplier”) of the other part:

WHEREAS the Purchaser invited bids for certain goods and ancillary services, viz.,

[brief description of goods and services]

and has accepted a tender by the Supplier for the supply of those goods and services in the sum of *[contract price in words and figures]* (hereinafter called “the Contract Price”).

NOW THIS AGREEMENT WITNESSETH AS FOLLOWS:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.:
 - a. Tender Form and the Price Schedule submitted by the Supplier;
 - b. The Schedule of Requirements;
 - c. The Technical Specifications;
 - d. The Conditions of Contract; and
 - e. The Purchaser’s Notification of Award.
3. In consideration of the payments to be made by the Purchaser to the Supplier as hereinafter mentioned, the Supplier hereby covenants with the Purchaser to provide the goods and services and to remedy defects therein in conformity in all respects with the provisions of the Contract.
4. The Purchaser hereby covenants to pay the Supplier in consideration of the provision of the goods and services and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with their respective laws the day and year first above written.

On behalf of the Purchaser

On behalf of the Supplier

Name:

Name:

Designation:

Designation:

Sign:

Sign:

Seal:

Seal:

Section IV. Sample Forms

1. Tender and Price Schedules

Gentlemen and/or Ladies:

Having examined the tender documents, we the undersigned, offer to supply and deliver

[description of goods and services]

in conformity with the said tender documents for the sum of _____ *[total tender amount figures]*. _____

[total tender amount in words] or such other sums as may be ascertained in accordance with the Schedule of Prices attached herewith and made part of this Tender.

We undertake, if our Tender is accepted, to deliver the goods in accordance with the delivery schedule specified in the Schedule of Requirements.

If our Tender is accepted, we will obtain the guarantee of a bank in a sum equivalent to **10%** of the Contract Price for the due performance of the Contract, in the form prescribed by the Purchaser.

We agree to abide by this Tender for a Period of **60 days** from the date fixed for Tender opening. It shall remain binding upon us and may be accepted at any time before the expiration of that period.

Until a formal Contract is prepared and executed, this Tender, together with your written acceptance thereof and your notification of award, shall constitute a binding Contract between us.

We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this _____ day of _____ 20____.

[name and signature of officer]

[in the capacity of]

Duly authorized to sign Tender for and on behalf of _____

[name of Company]

To: **Kwame Nkrumah University of Science and Technology, Kumasi**

1. We understand that, according to your conditions, tender must be supported by a Tender Securing Declaration.
2. We accept that we will automatically be suspended from being eligible for Tendering in any contract with the Purchaser for the period of **6 Months** starting on the date of notification of award of contract, if we are in breach of our obligation(s) under the bid conditions, because we:
 - have withdrawn our Tender during the period of tender validity specified by us in the Tendering Data Sheet; or
 - having been notified of the acceptance of our Tender by the Purchaser during the period of tender validity, (i) fail or refuse to execute the Contract, if required, or (ii) fail or refuse to furnish the Performance Security, in accordance with the ITB.
3. We understand this Tender Securing Declaration shall expire if we are not the successful Tenderer, upon the earlier of (i) our receipt of a copy of your notification of the name of the successful Tenderer; or (ii) twenty-eight days after the expiration of our Tender.
4. We understand that if we are a Joint Venture, the Tender Securing Declaration must be in the name of the Joint Venture that submits the Tender. If the Joint Venture has not been legally constituted at the time of bidding, the Tender Securing Declaration shall be in the names of all future partners as named in the letter of intent.

[signature] _____
[in the capacity of]

Duly authorized to sign the bid for and on behalf of: _____
[Insert complete name of Tenderer]

Price Schedule

Name of Supplier: _____

1	2	3	4	5	6	7	8	9
Item	Description	Country of origin	Quantity	Unit price EXW per item	Cost of Labour / Installation Where applicable	Sub-Total price per item (col. 4 x 5)	VAT+OTHER LEVIES	Total price per item (col.7+8)
Total								

Total Price to final destination(in words)

Please provide the following contact details;

Postal Address:

House/ Plot No. of Company's:

City/ Town:

Phone No.:.....

.....
Signature and Stamp of Tenderer

Note: In case of discrepancy between unit price and total, the unit price shall prevail.

Section V. Schedule of Delivery

The delivery schedule expressed as weeks/months stipulates hereafter a delivery date which is the date of delivery (i) at EXW premises, or (ii) to the carrier at the port of shipment or port of destination when the contract is placed on CIF or FOB terms, or (iii) to the first carrier when the contract is placed on CIP or FCA terms. In order to determine the correct date of delivery hereafter specified, the Purchaser has taken into account the additional time that will be needed for international or national transit to the Project Site or to another common place.¹

<u>Description</u>	<u>Quantity</u>	<u>Delivery Schedule (shipment)</u>
Procurement of Electronic Hardware and Networking Equipment for the Embedded Systems, Robotics, and Artificial Intelligence Laboratory at the Department of Computer Science, KNUST.	Various	8 Weeks after award of Contract

¹

The delivery may be specified for a single shipment, or for several partial shipments, for a specific date, or range of acceptable delivery periods.

TECHNICAL SPECIFICATIONS

PROCUREMENT OF ELECTRONIC HARDWARE AND NETWORKING EQUIPMENT FOR THE EMBEDDED SYSTEMS, ROBOTICS, AND ARTIFICIAL INTELLIGENCE LABORATORY AT THE DEPARTMENT OF COMPUTER SCIENCE, KNUST.

Tenderers must indicate either **COMPLY** or **NOT COMPLY** in the Offered column for each feature sought. The items to be offered should be based on the manufacturer's current standard models, which conform, as near as possible, to the specifications specified below:

S/No.	Quantity	Minimum Specifications Required		Offered Specification
		Microcontroller and Development Boards		
1.	30 No.	Microcontroller Development Boards		
		Main Microcontroller	Renesas RA4M1 (Arm® Cortex®-M4 with FPU)	
		Radio Module	ESP32-S3-MINI-1-N8	
		Clock Speed	RA4M1: 48 MHz ESP32-S3: up to 240 MHz	
		Memory (RA4M1)	256 kB Flash, 32 kB SRAM, 8 kB EEPROM	
		Memory (ESP32-S3)	384 kB ROM, 512 kB SRAM	
		USB	USB-C® (Programming Port / HID support)	
		Operating Voltage	5 V (RA4M1 / GPIOs); ESP32-S3 is 3.3 V	
		Input Voltage (VIN)	6–24 V	
		DC Current per I/O Pin	8 mA	
		Digital I/O Pins	14	
		Analog Input Pins	6	
		DAC	1 (12-bit, on A0)	
		PWM Pins	6	
		Communication	UART: 1× I2C: 1× (plus Qwiic connector) SPI: 1× CAN: 1×	
		Wireless	Wi-Fi® 4 (802.11 b/g/n, 2.4 GHz, up to 150 Mbps) Bluetooth® 5	
		Onboard Features	12×8 red LED matrix, RTC (with VRTC pin support),	

			Op-Amp, Qwiic connector, HID support	
		Dimensions	Width: 68.85 mm Length: 53.34 mm	
		Arduino® UNO R4 WiFi or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
2.	15 No.	Microcontroller Development Boards		
		Microcontroller	ATmega2560	
		USB Connector	USB-B	
		USB-Serial Processor	ATmega16U2	
		Clock Speed	16 MHz	
		Operating Voltage	5 V	
		Input Voltage (recommended)	7–12 V	
		Input Voltage (limit)	6–20 V	
		Digital I/O Pins	54 (of which 15 provide PWM output)	
		Analog Input Pins	16	
		PWM Pins	15	
		DC Current per I/O Pin	20 mA	
		DC Current for 3.3V Pin	50 mA	
		Flash Memory	256 KB (of which 8 KB used by the bootloader)	
		SRAM	8 KB	
		EEPROM	4 KB	
		Communication	UART: 4× I2C: Yes SPI: Yes	
		Built-in LED Pin	13	
		Power Supply Connector	Barrel Plug	
		Dimensions	Length: 101.5 mm Width: 53.3 mm	
		Weight	37 g	
		Arduino® Mega 2560 Rev3 or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		

3.	30 No.	Microcontroller Development Boards	
		Module	Typically ESP32-WROOM-32 / ESP32-WROOM-32E (variants available)
		MCU / SoC	ESP32 (Xtensa® dual-core 32-bit LX6 microprocessor)
		Clock Speed	Up to 240 MHz
		SRAM	520 KB
		Flash Memory	4 MB (typical, external SPI flash)
		Operating Voltage	3.3 V
		Power Supply	5 V via Micro-USB (default); also via 5V or 3V3 pins
		Recommended Current	≥ 500 mA
		GPIO / I/O Pins	34 (most broken out to headers)
		ADC	Up to 18 channels, 12-bit
		DAC	2 channels, 8-bit
		Wireless	Wi-Fi® 802.11 b/g/n (up to 150 Mbps, 2.4 GHz) Bluetooth® v4.2 BR/EDR + BLE
		Interfaces	UART, SPI, I2C, I2S, CAN, PWM, SDIO, Capacitive Touch, etc.
		USB-to-UART Bridge	CP2102 (or equivalent, up to 3 Mbps)
		Antenna	Onboard PCB antenna
		Buttons	EN (Reset), Boot
		Dimensions	Approx. 55 × 28 mm
		ESP32 DevKitC V4 (WiFi + BLE) or its equivalent	
		Please indicate the brand and model number of the product you intend to supply	
4.	25 No.	Single-Board Computers (SBCs)	
		Processor (SoC)	Broadcom BCM2712
		CPU	Quad-core 64-bit Arm Cortex-A76 @ 2.4 GHz (512 KB L2 cache per core, 2 MB shared L3 cache, cryptographic extensions)

		GPU	VideoCore VII (supports OpenGL ES 3.1, Vulkan 1.2/1.3)	
		RAM	8 GB LPDDR4X-4267 SDRAM	
		Storage	microSD card slot (supports high-speed SDR104 mode)	
		Display	Dual 4Kp60 HDMI® outputs with HDR support	
		Video Decode	4Kp60 HEVC decoder	
		Wireless	Dual-band 802.11ac Wi-Fi® Bluetooth 5.0 / Bluetooth Low Energy (BLE)	
		Ethernet	Gigabit Ethernet (PoE+ support requires separate PoE+ HAT)	
		USB Ports	2 × USB 3.0 (simultaneous 5 Gbps) 2 × USB 2.0	
		Camera / Display	2 × 4-lane MIPI camera/display transceivers	
		PCIe	PCIe 2.0 ×1 interface (requires M.2 HAT or adapter for peripherals)	
		GPIO	Standard 40-pin header	
		Power	5 V / 5 A DC via USB-C (with Power Delivery support)	
		Other Features	Real-time clock (RTC, external battery support) Power button Fan connector UART debug port	
		Form Factor	Standard board size	
		Raspberry Pi 5(8 GB RAM) or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
5.	30 No.	Wireless Microcontroller Boards		
		Microcontroller	RP2040	
		CPU	Dual-core Arm Cortex-M0+ @ up to 133 MHz	
		SRAM	264 KB on-chip	
		Flash Memory	2 MB on-board QSPI flash	
		Wireless	2.4 GHz IEEE 802.11 b/g/n Wi-Fi® (on-board antenna)	

			Bluetooth 5.2 (LE + Classic support)	
		GPIO	26 multi-function GPIO pins (including 3 analogue inputs)	
		Peripherals	2 × UART 2 × SPI controllers 2 × I2C controllers 16 × PWM channels 1 × USB 1.1 (host & device) 8 × Programmable I/O (PIO) state machines	
		ADC	3 × 12-bit analogue inputs	
		Input Power	1.8–5.5 V DC	
		USB	Micro-USB B (power, data, and drag-and-drop programming)	
		Form Factor	21 mm × 51 mm (castellated edges for surface-mount or through-hole)	
		Operating Temperature	–20°C to +70°C	
		Other Features	On-chip temperature sensor Low-power sleep & dormant modes Accurate on-chip clock SWD debug port	
		Raspberry Pi Pico W or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
6.	20 No.	Microcontroller Development Boards		
		Core	Arm® Cortex®-M4 with FPU + DSP instructions + ART Accelerator	
		Max CPU Frequency	180 MHz	
		Flash Memory	512 KB	
		SRAM	128 KB (+ 4 KB backup SRAM)	
		Operating Voltage	1.7 V – 3.6 V	
		GPIO	Up to 50 I/Os with external interrupt capability	
		ADC	3 × 12-bit (up to 16 channels)	
		DAC	2 × 12-bit	

		Timers	Up to 17 (including 2×32 -bit, multiple 16-bit, watchdogs, SysTick)	
		Communication Interfaces	USART/UART: up to 6 SPI: up to 4 I2C: up to 4 CAN: 2 USB OTG FS/HS SAI, SPDIF-Rx, HDMI-CEC, Quad-SPI, SDIO, Camera interface	
		On-board Debugger	ST-LINK/V2-1 (with SWD, Virtual COM port, mass storage)	
		Expansion Connectors	Arduino Uno V3 compatible ST Morpho headers (full MCU pin access)	
		User Interface	1 $\times$ User LED (LD2) 1 $\times$ User button 1 $\times$ Reset button	
		Power Supply Options	USB (ST-LINK) External 3.3 V / 5 V / 7–12 V	
		Crystal	32.768 kHz (for RTC)	
		Form Factor	Nucleo-64	
		STM32 Nucleo F446RE Dev Board or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
7.	30 No.	Microcontroller Development Boards		
		Microcontroller / SoC	ESP8266 (Tensilica L106 32-bit RISC processor)	
		Clock Speed	80 MHz (can be overclocked to 160 MHz)	
		SRAM	64–128 KB (typically ~80 KB usable)	
		Flash Memory	4 MB (typical)	
		Operating Voltage	3.3 V	
		Input Voltage	4.5–10 V (via VIN) or 5 V via Micro-USB	
		GPIO / Digital I/O	11–17 usable GPIO pins (11 commonly accessible)	
		Analog Input	1 $\times$ 10-bit ADC (A0, 0–3.3 V range)	
		PWM	Up to 4 channels	
		Interfaces	UART (1–2) SPI (1) I2C (1) I2S	

		Wireless	Wi-Fi 802.11 b/g/n (2.4 GHz)	
		USB	Micro-USB with onboard USB-to-Serial (CP2102 or CH340)	
		Antenna	Onboard PCB antenna	
		Operating Temperature	–40°C to +85°C / +125°C (depending on variant)	
		Dimensions	Approx. 49 × 26 mm	
		NodeMCU ESP8266 WiFi Board or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
8.	10 No.	Single-Board Computers (SBCs)		
		Processor (SoC)	Texas Instruments Sitara AM3358BZCZ100	
		CPU	1 GHz Arm® Cortex-A8 (up to 2000 MIPS)	
		Co-processors	2 × 32-bit 200 MHz Programmable Real-time Units (PRUs) NEON floating-point accelerator	
		GPU	PowerVR SGX530 3D (up to 20M polygons/s)	
		RAM	512 MB DDR3L @ 800 MHz	
		Onboard Storage	4 GB 8-bit eMMC	
		Expandable Storage	microSD card slot	
		Ethernet	10/100 Mbps RJ45	
		USB	1 × USB 2.0 Host (Type-A, 500 mA) 1 × USB 2.0 Client (mini-USB)	
		Video / Audio	microHDMI (up to 1920×1080@24 Hz, stereo audio)	
		Serial Debug	UART0 via 6-pin 3.3 V TTL header	
		Expansion Headers	2 × 46-pin (P8 & P9) – supports Capes Up to 69 GPIO, I2C, SPI, UART, PWM, ADC (7 × 1.8 V), CAN, etc.	

		Power	5 V via mini-USB or DC barrel jack (or expansion header)	
		Power Management	TPS65217C PMIC + additional LDO	
		User Interface	Power, Reset, and Boot buttons 1 power LED + 4 user-controllable LEDs	
		Debug	Optional 20-pin CTI JTAG	
		Dimensions	86.36 mm × 53.34 mm (3.4" × 2.1")	
		Weight	≈ 39.7 g	
		BeagleBone Black or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
		Communication and Networking Modules		
9.	15 No.	Transceivers		
		Chip	Semtech SX1276	
		Frequency Range	137 – 1020 MHz (optimized/common modules for 868 MHz ISM band)	
		Modulation	LoRa®, FSK, GFSK, MSK, GMSK, OOK	
		Max TX Power	+20 dBm (100 mW) via PA_BOOST +14 dBm high-efficiency PA	
		Receiver Sensitivity	Down to –148 dBm (LoRa mode)	
		Max Link Budget	168 dB	
		Spreading Factors	SF6 – SF12	
		Bandwidth Options	7.8 kHz – 500 kHz	
		Effective Bit Rate	0.018 – 37.5 kbps (LoRa) Up to 300 kbps (FSK)	
		Coding Rates	4/5, 4/6, 4/7, 4/8	
		Interface	SPI (up to 10 MHz)	
		Supply Voltage	1.8 – 3.7 V	
		RX Current	≈ 9.9 – 10.8 mA	
		Sleep Current	< 200 nA	
		Packet Engine	Up to 256 bytes with CRC	
		Other Features	Built-in temperature sensor & low-battery indicator 127 dB dynamic range RSSI	

			Preamble detection, CAD, AFC	
		Operating Temperature	–40°C to +85°C	
		Package (IC)	28-pin QFN	
		LoRa SX1276 Transceiver Module (868 MHz) or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
10.	10 No.	Wireless Communication Devices		
		MCU Core	Enhanced 8051 microcontroller (with code prefetch)	
		Flash Memory	32 / 64 / 128 / 256 KB (in-system programmable; modules often use 256 KB)	
		RAM	8 KB (with retention in all power modes)	
		Frequency	2.4 GHz (IEEE 802.15.4 compliant; 2405–2480 MHz typical)	
		Modulation	O-QPSK	
		Data Rate	250 kbps	
		TX Power	Programmable up to +4.5 dBm	
		Receiver Sensitivity	–97 dBm	
		RX Current	≈ 24 mA (CPU idle)	
		TX Current	≈ 29 mA at 1 dBm (CPU idle)	
		Sleep Current	Power Mode 1: 0.2 mA Power Mode 2: 1 μA Power Mode 3: 0.4 μA	
		Supply Voltage	2.0 – 3.6 V (typical 3.3 V)	
		GPIO	21 general-purpose I/O pins (19 × 4 mA, 2 × 20 mA)	
		Peripherals	2 × USART, 12-bit ADC (8 channels), AES security coprocessor, DMA, Timers, Battery monitor, Temperature sensor	
		Protocols	IEEE 802.15.4, Zigbee, RF4CE	

		Operating Temperature	–40°C to +85°C / +125°C (depending on variant)	
		Package (IC)	6 × 6 mm QFN-40	
		Typical Module Size	≈ 28 × 20 mm	
		Zigbee CC2530 Module or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
11.	20 No.	Wireless Serial Communication Devices		
		Bluetooth Version	Bluetooth 2.0 + EDR (Enhanced Data Rate)	
		Frequency	2.4 GHz ISM band (2.402 – 2.480 GHz)	
		Modulation	GFSK (Gaussian Frequency Shift Keying)	
		Class	Class 2	
		Transmit Power	Up to +4 dBm (typically ≤ 4 dBm)	
		Receiver Sensitivity	≈ –80 to –84 dBm (at 0.1% BER)	
		Range	Up to 10 meters (open space / line-of-sight)	
		Data Rate	Asynchronous: up to 2.1 Mbps Synchronous: 1 Mbps	
		Interface	UART (TXD / RXD)	
		Supported Baud Rates	1200, 2400, 4800, 9600 (default data mode), 19200, 38400 (default AT mode), 57600, 115200, 230400, 460800	
		Operating Modes	Master / Slave (configurable via AT commands) Data Mode / AT Command Mode	
		Supply Voltage	3.6 – 6 V (onboard regulator; logic level 3.3 V)	
		Current Consumption	≈ 30–40 mA (active / pairing) ≈ 8–10 mA (connected) < 1 mA (standby/sleep)	
		Profiles	SPP (Serial Port Profile)	
		Default Settings	Name: HC-05 PIN/Password: 1234 or 0000 Baud: 9600 (data), 38400 (AT)	

		Antenna	Integrated PCB antenna	
		Operating Temperature	−20°C to +75°C (typical)	
		Dimensions	≈ 27 × 13 × 2 mm (core module); breakout boards ≈ 37 × 15 mm	
		Bluetooth HC 05 Module or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
12.	20 No.	Wireless Transceivers		
		Chip	Nordic Semiconductor	
		Frequency	2.400 – 2.525 GHz (2.4 GHz ISM band)	
		Modulation	GFSK	
		Air Data Rates	250 kbps, 1 Mbps, 2 Mbps	
		RF Channels	126	
		TX Output Power	Programmable: 0 dBm, −6 dBm, −12 dBm, −18 dBm	
		Receiver Sensitivity	−82 dBm @ 2 Mbps −85 dBm @ 1 Mbps −94 dBm @ 250 kbps	
		TX Current	11.3 mA @ 0 dBm	
		RX Current	13.5 mA @ 2 Mbps	
		Standby Current	26 μA (Standby-I)	
		Power-Down Current	900 nA	
		Supply Voltage	1.9 – 3.6 V	
		Interface	SPI (up to 10 Mbps), 5 V tolerant inputs	
		Protocol Engine	Enhanced ShockBurst™ (auto ACK, auto retransmit, dynamic payload)	
		Payload Length	1 – 32 bytes (dynamic)	
		MultiCeiver	6 data pipes (1:6 star network support)	
		Crystal	External 16 MHz (±60 ppm)	
		Package	20-pin 4×4 mm QFN	
		Operating Temperature	−40°C to +85°C	
		NRF24L01+ Wireless Transceiver or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		

13.	10 No.	Network Expansion and Internet Controller Devices		
		Chip	WIZnet W5500 (Hardwired TCP/IP Ethernet Controller)	
		Ethernet	10/100 Mbps (10Base-T / 100Base-TX) with embedded PHY	
		TCP/IP Protocols	Hardware-supported: TCP, UDP, ICMP, IPv4, ARP, IGMP, PPPoE	
		Sockets	8 independent hardware sockets	
		Internal Memory	32 KB TX/RX buffer	
		Interface	SPI (Mode 0 / Mode 3, up to 80 MHz)	
		Voltage	3.3 V operation with 5 V I/O tolerance (compatible with 5 V Arduino boards)	
		Auto Negotiation	Full / Half duplex, 10 / 100 Mbps	
		Power Features	Power-down mode Wake-on-LAN (WOL) over UDP	
		Storage	Micro-SD card slot (FAT16/FAT32 support)	
		Additional Interfaces	Grove connectors (I2C + UART) on many versions User-selectable GPIO	
		LEDs	Link, Speed, Full/Half duplex, Active	
		Reset	Onboard reset button (resets shield + Arduino)	
		Form Factor	Arduino Uno R3 shield compatible	
		Typical Dimensions	$\approx 71 \times 53 \times 23$ mm	
		Ethernet Shield W5500 or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
14.	5 No.	Cellular Communication Modules		
		Module	SIMCom SIM7600 series (Cat-4)	
		Network	4G LTE	
		Max Speed	150 Mbps down / 50 Mbps up (LTE Cat-4)	

		GNSS	GPS + BeiDou + GLONASS + Galileo	
		Interfaces	USB + UART + SIM slot + Audio jack	
		Power	5 V (3.3 V / 5 V logic selectable)	
		Form Factor	Raspberry Pi 40-pin HAT	
		Size	$\approx 56 \times 65$ mm	
		Key Features	Dial-up, SMS, Voice calls, AT commands	
		4G/LTE SIM7600 HAT or its equivalent		
		Please indicate the brand and model number of the product you intend to supply		
15.	30 No.	USB WiFi Adapters		
		Wi-Fi Standard	Wi-Fi 5 (802.11ac) or Wi-Fi 6 (802.11ax)	
		Bands	Dual-band (2.4 GHz + 5 GHz)	
		Max Speed	Wi-Fi 5: up to 1200–1900 Mbps Wi-Fi 6: up to 1800 Mbps	
		Interface	USB 3.0 / USB 3.2 (preferred) or USB 2.0	
		Antenna	External (1 or 2 antennas) or internal	
		Security	WPA2 / WPA3	
		OS Support	Windows 10/11, macOS, Linux	
		Power	Bus-powered via USB	
		Form Factor	USB dongle or larger adapter with stand/cradle	
		Please indicate the brand of the product you intend to supply		
		Computing and Display Infrastructure		
16.	1 No.	Projector		
		Type	Ceiling-Mounted Multimedia Projector	
		Projection Technology	LCD/DLP	
		Brightness	4,000 lumens	
		Resolution	Full HD (1920 x 1080) or WUXGA (1920 x 1200)	

		Throw Ratio	Long throw, suitable for large rooms	
		Connectivity	HDMI (x2), VGA, USB, Wi-Fi/LAN	
		Screen Size	Projection up to 150-200"	
		Lamp Life	Minimum 5,000 hours (normal mode)	
		Mounting	Ceiling mount bracket included	
		Please indicate the brand and model number of the product you intend to supply		
17.	1 No.	Projector Screen		
		Diagonal Size	100 inches	
		Aspect Ratio	16:9	
		Viewing Area	≈ 87" W × 49" H	
		Screen Type	Fixed-frame (wall mount)	
		Screen Material	Matte White (Gain ≈ 1.0 – 1.3)	
		Viewing Angle	160° – 180°	
		Frame	Aluminium with black velvet border	
		Mounting	Wall-mounted (fixed)	
		Compatibility	Standard / Short-throw projectors (some ALR versions for UST)	
		Overall Size	≈ 92–94" W × 53–56" H	
		Please indicate the brand and model number of the product you intend to supply		
18.	1 No.	Network Switch		
		Device Type	Managed Network Switch	
		Ports	48 × 10/100/1000 Mbps RJ45	
		Uplink ports	2–4 × SFP or 4 × 10G SFP+	
		Switching capacity	96–176 Gbps	
		Forwarding rate	71–131 Mpps	
		MAC address table	8K–32K (16K common)	
		Management	Web GUI + CLI + SNMP	
		Key features	VLAN, QoS, STP/RSTP/MSTP, LACP, IGMP Snooping, ACL	
		Form factor	1U rack-mountable	

		Power	100–240 V AC (non-PoE: ~30–60 W)	
		Please indicate the brand and model number of the product you intend to supply		
19.	2 No.	Dual-Band Wireless Access Point		
		Wi-Fi Standard	Wi-Fi 5 (802.11ac) or Wi-Fi 6 (802.11ax)	
		Bands	Dual-band concurrent: 2.4 GHz + 5 GHz	
		Max Data Rate	1.2–3.5 Gbps combined (higher on Wi-Fi 6)	
		MIMO / Spatial Streams	2×2 to 4×4 MU-MIMO	
		Ethernet Port	1 × Gigabit (or 2.5 GbE on newer models)	
		Power	PoE / PoE+ (802.3af/at); 12–25 W typical	
		Max Clients	100–250+ recommended	
		Key Features	Multiple SSIDs, VLAN, WPA2/WPA3, MU-MIMO, OFDMA (Wi-Fi 6), Beamforming	
		Mounting	Ceiling or wall (indoor)	
		Management	Standalone, controller, or cloud	
		Please indicate the brand and model number of the product you intend to supply		
20.	5 No.	Uninterrupted Power Supply (UPS)		
		Capacity	2000 VA	
		Topology	Line-Interactive with AVR	
		Input Voltage	160–290 VAC (nominal 220/230/240 V)	
		Input Frequency	50/60 Hz auto-sensing	
		Output Voltage	220/230/240 VAC	
		Output Waveform	Simulated sine wave (or pure sine on higher-end)	
		Transfer Time	2–6 ms (typical)	
		Battery	24 V or 48 V (2–4 × 12 V sealed lead-acid)	
		Typical Backup	5–15 min (half load) / 2–8 min (full load)	
		Efficiency	≥90–95% (line mode)	

		Key Protections	Overload, short-circuit, over/under voltage	
		Interfaces	USB / RS-232 (SNMP optional)	
		Please indicate the brand and model number of the product you intend to supply		
		IoT Platforms, Displays and Accessories		
21.	30 No.	OLED Display Modules		
		Display Type	Passive Matrix OLED (PMOLED)	
		Diagonal Size	0.96 inch	
		Resolution	128 × 64 pixels	
		Controller IC	SSD1306	
		Interface	I2C	
		I2C Address	0x3C	
		Display Color	Monochrome (White / Blue / Yellow; dual-color versions available)	
		Active Area	≈ 21.74 × 10.86 mm	
		Pixel Size / Pitch	≈ 0.15 × 0.15 mm / 0.17 × 0.17 mm	
		Module Dimensions	≈ 27–28 × 27–28 × 3–4 mm (PCB breakout versions)	
		Operating Voltage	3.3 V – 5 V	
		Logic Voltage	1.65 V – 3.3 V (typically 3.3 V)	
		Typical Current	~8–20 mA (display on, content-dependent); < 1–2 mA (off/sleep)	
		Contrast Ratio	≥ 2000:1	
		Viewing Angle	> 160°	
		Brightness	≈ 100–180 cd/m ² (typical)	
		Operating Temperature	–40 °C to +70/85 °C	
		Storage Temperature	–40 °C to +85 °C	
		Lifetime	~10,000 hours (at typical brightness)	
		Pinout (4-pin I2C)	VCC, GND, SCL, SDA	
		Please indicate the brand of the product you intend to supply		

22.	30 No.	LCD Display		
		Display Type	Character LCD (STN/TN)	
		Display Format	16 characters × 2 lines	
		Character Matrix	5 × 8 dots (with cursor)	
		Interface	I2C (typically via PCF8574 / PCF8574A backpack)	
		Default I2C Address	0x27 or 0x3F (selectable via A0/A1/A2 jumpers; range usually 0x20–0x27 or 0x38–0x3F)	
		Controller	HD44780 or compatible (e.g. ST7066)	
		Operating Voltage	5 V	
		Logic Supply Current	~1–4 mA (without backlight)	
		Total Current (with backlight)	~20–30 mA typical (varies by backlight)	
		Backlight	LED (commonly blue, yellow-green, or white); adjustable contrast via onboard potentiometer	
		Duty Cycle / Bias	1/16 duty, typically 1/5 bias	
		Module Dimensions	~80 × 36 × 12–18 mm (L × W × H, including backpack)	
		Viewing Area	~64 × 16 mm	
		Character Size	~2.95 × 5.55 mm	
		Dot Size / Pitch	~0.55 × 0.65 mm / 0.60 × 0.70 mm	
		Operating Temperature	0 °C to +50 °C (standard); some –20 °C to +70 °C	
		Storage Temperature	–20 °C to +70 °C (or wider on extended versions)	
		Pins (I2C version)	4 pins: VCC, GND, SDA, SCL	
		Please indicate the brand of the product you intend to supply		
23.	10 No.	TFT LCD (Touchscreen)		
		Display Size	3.5 inch (diagonal)	
		Display Type	TFT LCD	
		Resolution	320 × 480 pixels	
		Colors	65,536 (16-bit)	
		Aspect Ratio	≈ 8:5	
		Touch Type	Resistive	

		Touch Controller	XPT2046	
		Display Driver IC	ILI9486	
		Interface	SPI (up to ~32 MHz)	
		Connection	Direct plug-in to Raspberry Pi 40-pin GPIO header	
		Compatibility	Raspberry Pi A/B/A+/B+/2B/3B/3B+/4B/5	
		Operating Voltage	5 V	
		Logic Level	3.3 V	
		Power Consumption	$\approx 0.13 \text{ A @ } 5 \text{ V}$ ($\approx 0.65 \text{ W}$ typical)	
		Backlight	LED (often adjustable via software/PWM)	
		Backlight Current	$\approx 120 \text{ mA}$	
		Active Area	$\approx 48.96 \times 73.44 \text{ mm}$	
		Module Dimensions	$\approx 85.4 \times 55.6 \text{ mm}$	
		Operating Temperature	$-20 \text{ }^{\circ}\text{C}$ to $+60 \text{ }^{\circ}\text{C}$	
		Supported OS	Raspberry Pi OS (Raspbian), Ubuntu, Kali Linux	
		Please indicate the brand of the product you intend to supply		
24.	30 No.	MicroSD Cards		
		Capacity	32GB	
		Form Factor	microSD	
		Speed Class	Class 10	
		Minimum Write Speed	10 MB/s	
		Typical Read Speed	20–100 MB/s	
		Bus Interface	UHS-I	
		File System	FAT32	
		Dimensions	15mm $\times$ 11mm $\times$ 1 mm	
		Please indicate the brand of the product you intend to supply		
25.	40 No.	USB A to Micro USB Cable		
		Length	1m	
		Connector A	USB Type-A (Male)	
		Connector B	Micro-USB Type-B (Male)	

		USB Standard	USB 2.0	
		Data Transfer Rate	Up to 480 Mbps	
		Function	Data transfer + charging	
		Cable Type	Shielded	
26.	40 No.	USB A to USB C Cable		
		Length	1m	
		Connector A	USB Type-A (Male)	
		Connector B	USB Type-C (Male)	
		USB Standard	USB 2.0	
		Data Transfer Rate	Up to 480 Mbps	
		Function	Data transfer + charging	
		Cable Type	Shielded	
		Please indicate the brand of the product you intend to supply		
27.	25 No.	Active Cooling Plastic Cases		
		Compatibility	Raspberry Pi 5	
		Cooling	Integrated temperature-controlled PWM fan + heatsink	
		Fan Size / Type	Axial fan with fluid dynamic bearings	
		Max Fan Speed	8000 RPM $\pm$ 15%	
		Max Airflow	2.79 CFM	
		Fan Control	PWM + tachometer (connects to Pi 5 4-pin header)	
		Heatsink	12 $\times$ 17 $\times$ 4 mm (self-adhesive)	
		Material	ABS (base, frame, lid) + PC (fan assembly)	
		Dimensions (approx.)	98 $\times$ 70 $\times$ 31mm	
		Features	Removable lid, GPIO access slot, stacking support, silicone feet	
		Please indicate the brand of the product you intend to supply		
28.	10 No.	Camera Modules		
		Type	Camera Module 3 (Version 3)	

		Sensor	Sony IMX708 or its equivalent	
		Resolution	12 megapixels (4608 × 2592)	
		Pixel Size	1.4 μm × 1.4 μm	
		Sensor Size	7.4 mm diagonal (1/2.43")	
		Autofocus	Phase Detection Autofocus (PDAF)	
		Focus Range	10 cm – ∞	
		Field of View	75° (Standard) / 120° (Wide)	
		Focal Length	4.74 mm (Standard) / 2.75 mm (Wide)	
		Interface	15-pin/22-pin CSI-2 connector (MIPI CSI-2)	
		Aperture	F1.8 (Standard) / F2.2 (Wide)	
		Video Resolution	Up to 1080p50	
		Still Capture	Up to 12MP	
		HDR Support	Yes (on-sensor HDR mode)	
		IR Cut Filter	Yes (Standard) / No (NoIR versions)	
		Dimensions	Approx. 25 × 24 × 11.5 mm	
		Compatibility	Raspberry Pi models with CSI port (Pi 3, 4, 5, Zero via adapter cable, etc.)	
		Cable	200 mm ribbon, 15-pin FPC	
		Please indicate the brand and model number of the product you intend to supply		
29.	15 No.	Power Strips		
		Number of Outlets	6	
		Surge Protection	Yes	
		Joule Rating	300–2000 J	
		Maximum Load	15 A / 1875 W	
		Voltage	120 V AC	
		Cord Length	1–2 m	
		Plug Type	Standard grounded	
		Additional Features	Includes indicator light, circuit breaker, spaced outlets	
		Please indicate the brand and model number of the product you intend to supply		
Delivery Period: 8 Weeks after award of contract				
Warranty Period: 1 Year after delivery				