MANUFACTURING AND ENGINEERING TECHNOLOGY

Electronics

WorldSkills Occupational Standards

 WSC2021_WSOS16_Electronics

WorldSkills Occupational Standards (WSOS)

General notes on the WSOS

The WSOS specifies the knowledge, understanding, and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSOS).

The skill competition is intended to reflect international best practice as described by the WSOS, and to the extent that it is able to. The Standard is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standard is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards. This is often referred to as the "weighting". The sum of all the percentage marks is 100. The weightings determine the distribution of marks within the Marking Scheme.

Through the Test Project, the Marking Scheme will assess only those skills that are set out in the Standards Specification. They will reflect the Standards as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme will follow the allocation of marks within the Standards to the extent practically possible. A variation of up to five percent is allowed, provided that this does not distort the weightings assigned by the Standards.

WorldSkills Occupational Standards

Section		Relative importance (%)
1	**Work organization and management**	**10**

The individual needs to know and understand:

- Creativity in the design of circuits, PCB layout, and programming
- Critical thinking in the design of circuits, PCB, fault-finding, and programming
- Honesty and integrity
- Self-motivation
- Problem-solving
- Effective working under pressure
- Health and safety legislation
- Best practices in relation to skills
- The importance of continuing personal development
- Company cultures and procedures and potential variations dependent on national practice

The individual shall be able to:

- Work professionally in relation to the environment and others
- Work with colleagues and teams both in the local environment and remotely
- Present ideas to teams and clients
- Exercise care in the workplace for personal and other's safety
- Take appropriate preventative action to minimize accidents and their impact
- Proactively engage in continuing professional development
- Develop effective record keeping practices to facilitate traceability for future development and maintenance and to comply with international standards
- Interpret and recognise international symbols, diagrams and languages used by other International Standards Institutes Source and purchase components and test equipment to meet specifications and be cost effective
- Write reports and record data about testing techniques, laboratory equipment and specifications to assist engineers
- Communicate effectively with customers
- Train others on the use of installations
- Keep up to date with changes in technology
- Act professionally on clients' premises
- Initiate records for on-going maintenance policy
- Establish maintenance contracts where appropriate

Section		Relative importance (%)
2	**Application of electronics in practice**	**15**

The individual needs to know and understand:

- The various electronics specialisms within specific industries
- Commonly used and International industry standard symbols
- Commonly used units of distance measurement (mils and mm)
- The business environment of the client
- materials and tools of the electronics industry in ordinary servicing, installation, and repair tasks (Electronic Circuit Component Specifications
- Analogue and digital logic circuit and sensor circuit
- AC and DC technology
- Power
- Wire and cables
- Connectors
- Displays
- Circuit Design
- Analysis, of electrical circuits, electronic circuits, digital logic circuits and sensor circuits
- Inductive and capacitive reactance
- Capacitor and inductor characteristic charging and discharging behaviour
- Capacitor selection and suitability to application
- Passive and Active Filters
- Oscillators (RC, Crystal, PLL)
- Multistage Circuits
- Basic amplifier circuits (AC, DC, and power amplifiers)
- Basic Op Amp circuits
- Practical Operational Amplifier considerations. PID Control and servo systems
- Generators and pulse shapers
- Generators for sine wave voltage: RC, quartz, LC oscillators, Wien bridge generator, phase generator
- Pulse shaper: Schmitt trigger, differentiator, and integrator
- Race Conditions
- Truth tables, timing diagrams, karnaugh mapping, boolean algebra, combinational logic, combinational logic applications
- Number systems
- Properties of basic gates AND, OR, NOT, NAND, NOR, EXCLUSIVE OR EXCLUSIVE NOR
- Procedures for substituting basic NAND or NOR gates for basic gates
- Methods for creating digital logic to perform specified operations
- Digital logic equation/functions from given circuits.
- Industry standard waveform measurement characteristics Combinational and sequential logic circuits.
- EMI Shielding techniques
- Electrostatic Discharge (ESD) best practices

Section		Relative importance (%)

	The individual shall be able to:
	• Identify and analyse the appropriate principle for the task
	• Apply cognitive skills as appropriate to the task
	• Use computers as a tool to perform
	  • circuit design, PCB Layout and Simulation
	  • programming of embedded devices
	  • test and measurement of components and circuit operation to given specifications
	  • The control of circuit boards and production machinery
	• Create communication links typically used in embedded systems.
	• Interface MCUs to external devices.
	• Read and interpret engineering drawings, wiring diagrams, schematic drawings, technical manuals, and engineering instructions
	• Install equipment, components, units, upgrades, or refurbished equipment into service	

3	**Prototype hardware design**	**25**
	The individual needs to know and understand: • The application of electronic principles • Specialist (PCB design) software • Design that is fit for purpose • The process of converting a design into actuality	
	The individual shall be able to: • Calculate and select component values that are fit-for-purpose • Implement heatsinking principles • Design modifications to given basic electronics blocks • Design circuits that meet specification and are fit for purpose. • Use computer circuit simulation software to test that circuit designs are fit for purpose. Discuss and interpret design briefs and specifications • Draw schematic circuits using schematic capture and PCB layout software • Use the 3D capabilities of PCB Layout software. • Lay out PCBs using industry best practices • Generate fit-for-purpose PCB manufacturing data. • Assemble components onto PCBs to create functional circuits • Test prototypes and adjust as required • Implement rework and repair mistakes in design to industry standards	

Section		Relative importance (%)
4	**Embedded systems programming**	**25**

The individual needs to know and understand:

- Embedded Systems
- Microcontrollers
- Microcontroller Development Tools
- Integrated Software Development Environments commonly used in industry
- Device Programming methods.
- Programming embedded systems using the C-language and industry best practices
- The application of microcontroller interfacing principles
- Common MCU peripherals Programming and interfaces to external peripherals Power management techniques Watch-dog timers
- Interrupt handling (ISRs) and resets

The individual shall be able to:

- Locate, correct and re-compile syntax errors
- Write, compile, upload, test, and debug C-code that performs to specification.
- Use common C functions
- Use supplied functions
- Write functions to perform a specified task
- Open, compile and upload pre-written code onto embedded systems.
- Modify, debug, download, verify/test pre-written codes on embedded systems
- Design, write, debug, download/upload, and verify/test programs to solve/perform specified tasks
- Use and/or write interrupt handlers (ISRs) and/or polling techniques where appropriate
- Use generally accepted best practices when writing code
- Use pre-written code and/or design and write code that implements power management techniques

Section		Relative importance (%)
5	**Fault finding and repair**	**15**

The individual needs to know and understand:

- The application of electronic principles
- Contexts in which the function of fault finding, testing, repair and measurement takes place. The limitations and applications of test equipment
- Implications of unreliable equipment on business and preventative maintenance
- Techniques used to isolate faults
- Techniques used to make measurements on practical circuits
- Software techniques used in troubleshooting embedded systems
- How to work safely with high voltage and high currents
- Effects of ESD and working safely with ESD sensitive devices
- When to adopt safe and appropriate alternatives, shortcuts, and solutions

The individual shall be able to:

- Check the functionality and calibration of test equipment.
- Select the appropriate equipment to perform measurements.
- Take measurements to test, set, adjust, and measure electronic components, modules, and equipment using measurement equipment that can measure and analyse voltage, currents, and waveforms.
- Determine causes of operating errors and the required action to repair.
- Isolate faults to the component level.
- Adjust/replace/upgrade defective or improperly functioning circuitry and/or electronics components, using hand-tools and through-hole and surface mount soldering techniques
- Test electronics units and components, using standard test equipment
- Analyse results to evaluate performance against specification and determine the need for adjustment
- Record evidence of successful repair
- Collect and analyse the evidence both manually and remotely
- Complete repair reports that record the nature, evidence, cause, and repairs performed on faulty units
- Support the development of preventative maintenance schedules
- Perform preventative maintenance and calibration of equipment and systems
- Use automatic test equipment
- Use digital documentation
- Measure specific electrical parameters with precision and/or plotting variations over time in order to determine correct circuit functionality
- Determine if an electronic component meets specification
- Design and implement test strategies to localize/find faults
- Use computers as a tool to perform test routines, implement test strategies and collect and analyse test data
- Replace components and perform rework to industry standards

Section		Relative importance (%)
	• Replace components or modules with ones not originally designed or intended for use in a PCB or System, to obtain temporary functionality or for use in prototypes	
6	**Assembly and Measurement**	**10**
	The individual needs to know and understand: • Relevant industry standards. • The application of electronic principles • The purposes and functions of components to fulfil required tasks • Typical tools used in electronic assembly • Safe working practices • ESD safe working practices • How to make, save and print accurate DSO measurements	
	The individual shall be able to: • Identify and assemble and use electro-mechanical parts. • Identify and assemble common sensors. Assemble mechanical parts to form working units • Wire and form cables harnesses • Identify, assemble, and use various types of parts and surface mounted device parts • Work to correct sequences and tolerances • Solder components using lead free solder to comply with industry standards • Install, test, and calibrate a completed assembly to customer specifications	
	Total	**100**

References for industry consultation

WorldSkills is committed to ensuring that the WorldSkills Occupational Standards fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and WorldSkills Occupational Standards on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- ISCO-08: (http://www.ilo.org/public/english/bureau/stat/isco/isco08/) ILO 3114
- ESCO: (https://ec.europa.eu/esco/portal/home)
- O*NET OnLine (www.**onet**online.org/)

This WSOS appears most closely to relate to a *Microelectronics Engineering Technician*:
http://data.europa.eu/esco/occupation/0ea36a48-a27d-4515-b61f-3cab395cf60f

and/or *Electronics Engineering Technicians:*
https://www.onetonline.org/link/summary/17-3023.01.

These links can also be used to explore adjacent occupations.

The following table indicates which organizations were approached and provided valuable feedback for the Description of the Associated Role and WorldSkills Occupational Standards in place for WorldSkills Shanghai 2021.

Organization	Contact name
National Instruments (Global)	Ilya Stepanenko, Engineering Project Manager
«Rosenergoatom» Joint Stock Company (Electric Power Division of Rosatom) (Global)	Vadim Tukmachov, Chief of the Industry Skill Center