Test Project

Industrial Robotics skill

The Test Project comprises the following sections:

1. Forms of competition participation
2. Test Project Task
3. Project modules and time required
4. Assessment Criteria
5. Required appendices

Time allotted to complete the task: 21 hours

1. FORMS OF COMPETITION PARTICIPATION

Individual participation.

2. TEST PROJECT TASK

This Test Project focuses on Industrial Robotics. The competitors are given instructions, pneumatic and electrical circuit diagrams, and the equipment layout. The Test Project consists of 6 modules to be completed in turn.

The Test Project includes commissioning of robot-assisted systems (RAS) based on the following modules:

1.) Robotic welding
2.) Milling
3.) Machine loading/unloading
4.) Palletizing
5.) Painting an article

The sixth module is the project presentation.

The task and Criteria may be changed only if it is not possible to implement the workshop and with the approval of the Skill Competition Manager.

If a competitor does not comply with the OHSE requirements or exposes themselves and/or other competitors to danger, they may be disqualified.

The Test Project is to be completed in turn according to random draw. The results are to be scored when the competitor has finished the module.

3. PROJECT MODULES AND TIME REQUIRED

The modules and times are given in Table 1.

Table 1.

No.	Module description	Project completion time
1	Module 1. Robotic welding	120 minutes
2	Module 2. Milling	120 minutes
3	Module 3. Machine loading/unloading	120 minutes
4	Module 4. Palletizing	120 minutes
5	Module 5. Painting an article	105 minutes
6	Module 6. Project presentation	240 minutes

Module 1. Robotic welding

The competitor shall commission a robotic welding cell.
The commissioning works include the following:
1.) Installation.
2.) Voltage supply. End of installation.
3.) Project uploading, system functional check.
4.) Tool and base calibration.
5.) Writing a tool cleaning program.
6.) Writing a welding test program.
7.) Saving the image of the configured robotic cell.

Item 1. Installation.

State of the equipment: the welding equipment is laid out on the table element by element together with fasteners. The robot stands in the training cell, the power and data cables between the robot controller and the industrial robot are connected. The control unit of the industrial robot is also connected.

1.) Install the collision protection and the welding torch on the robot flange. In this case, the projection of the torch axis on the coordinate system of the robot flange shall lie only on axis Ox and Oz in the positive direction.
2.) Install a wire drawing device on the 4th axis of the industrial robot.
3.) Pull the armoring inside the hose.
4.) Connect the hose to the wire drawing device and the welding torch.
5.) Connect the power and data cables from the welding machine to the wire-drawing device.
6.) Install the welding wire coil holder.
7.) Install the welding wire coil in the holder.
8.) Install the tool cleaning station in the robot work booth according to the equipment layout.
9.) Connect the aerial circuit to the tool cleaning station as per the pneumatic circuit diagram.
10.) Connect the signals from the tool cleaning station to the industrial robot controller as per the electrical circuit diagram.
11.) Install the welding jig on the cell work desk according to the equipment layout.
12.) Connect the ground cable from the welding machine to the welding jig.
13.) Connect the data cable from the welding machine to the robot controller.

The assembled robot-assisted system shall be checked by the Expert when the installation is complete. The Expert shall sign the "Report on Robot-Assisted System Assembly Check" to give authorization for powering up the RAS (see Appendix 1).

After the Report on Robot-Assisted System Assembly Check has been signed, the Expert shall disconnect the positive cable from the welding source.

Item 2. Installation. Voltage supply. End of installation.
1.) Plug in the industrial robot.
2.) Plug in the welding machine.
3.) Thread the wire in the wire drawing device.
4.) Lower the pinch rollers and set the sufficient force for drawing the wire.
5.) Extend the wire until it extends beyond the welding tip by 30 mm using the button for switching on the pinch rollers.

Item 3. Project uploading, system functional check.
1.) Turn on the laptop and run the program to configure the robot.
2.) Upload the project of the configured cell in the industrial robot controller. The configured project is on the desktop in the "Welding Robot" folder under the name WeldingAgilus.
3.) Turn on the compressor and set the outlet pressure to 6 bar.
4.) Perform an element-by-element functional check of the tool cleaning system (wire cutting, torch holding, torch cleaning, torch lubricating) using inputs/outputs.
5.) Enable the display of function keys in the controller menu.
6.) Check the wire supply from the robot control unit using the function keys.
7.) Cut the wire with manual wire cutters. Ensure that the wire sticks out by 25 mm.

Item 4. Tool and base calibration.
1.) Calibrate the welding torch. Use number 1 for the tool to store the information on the tool calibration. The tool name shall be "Torch20mm". The end of the welding wire with a 20 mm stickout shall be taken as the TCP. The welding wire stickout distance is measured from the end of the welding tip to the end of the wire. The tool calibration tolerance shall be within 0,5 mm.
2.) Calibrate the direction of the tool stroke.
3.) Calibrate the base of the welding table. Take the left-hand corner of the welding table nearest to the robot as the origin point. Use number 1 for the base to store the information on the base calibration. The base name shall be "MainBase".
4.) Calibrate the tool cleaning base. Take the left-hand corner of the tool cleaning nearest to the robot as the origin point. Use number 2 for the base to store the information on the base calibration. The base name shall be "CleaningStation".

Item 5. Tool and base calibration.

    1.)   Create a folder for storing additional welding programs with the name "Additional" in the Program folder.

    2.)   It is necessary to write a tool cleaning program. The program name shall be "CleaningTorch". The "CleaningStation" base and "Torch20mm" tool shall be used when writing the program. The movement forms shall contain the speed of accessing the tool cleaning station and moving away from it to the end point; its value shall be 0.4 m/s. The movement forms shall also contain the speed of accessing all the final control elements of the cleaning station; its value shall be 0.2 m/s. The speed of PTP type movements shall be 20%. The welding torch shall stay at the cleaning point for 5 seconds. The first PTP movement of the robot shall differ from the first movement of the robot in other programs created by the user.

    3.)   The program shall be tested in T1 mode.

    4.)   The program shall be tested in T2 mode at a forced reduction of speed by 50%.

    5.)   The program shall be tested in AUT mode at a forced reduction of speed by 50%.

Item 6. Writing a welding test program.

    1.)   Create a folder named "TypicalWelding" in the Program folder to store the first welding program.

    2.)   Create "MyFirstWeld" program.

    3.)   Write a robot-assisted work program according to the provided welding product;

    4.)   The movement forms shall contain the speed of accessing the part and moving away from it to the end point; its value shall be 0.4 m/s. The ArcOn form shall contain the speed of accessing the beginning of the arc ignition point; its value shall be 0.2 m/s. The speed of PTP type movements shall be 20%.

    5.)   The tool cleaning program shall be called up after the first movement in the test part welding program.

    6.)   To start welding (ignite the arc), it is necessary to use the ArcOn form with the following parameters:

        Arc ignition parameters:

           a. JOB - 1

           b) Preflow time: 0.3 s

           c) Delay time – 0.3 s

        Welding seam parameters:

a. JOB - 1

b. Welding speed: 0.4 m/min

Oscillation parameters

a. None

7.) To finish welding (extinguish the arc), it is necessary to use the ArcOff form with the following parameters:

Arc extinguishing parameters

a. JOB -1

b) Preflow time: 0.3 s

c) Delay time – 0.3 s

8.) During work, the robot shall not collide with anything.
9.) To test the written program, the program launch mode shall be selected without igniting the arc. This mode is to be selected using the function keys.
10.) The program shall be tested in T1 mode.
11.) The program shall be tested in T2 mode at a forced reduction of speed by 50%.
12.) The program shall be tested in AUT mode at a forced reduction of speed by 50%.

Item 7. Saving the image of the configured robotic cell.
1.) Save the image of the industrial robot system using Recovery Stick.
2.) To save the image, it is necessary to create a folder named "BackUp …" in the "Welding Robot" folder, where the dots shall be replaced with the industrial robot number.

Module 2. Milling

The competitor shall commission a robotic milling machine.
The commissioning works include the following:
1.) Installation.
2.) Voltage supply. End of installation.
3.) Project uploading, system functional check.
4.) Tool and base calibration.
5.) Writing a spindle control test program.
6.) Running a milling program.
7.) Saving the image of the configured robotic cell.

Item 1. Installation.

State of the equipment: the equipment is laid out on the table element by element together with fasteners. The robot stands in the training cell, the power and data cables between the robot controller and the industrial robot are connected. The control unit of the industrial robot is also connected.

1.) Install the spindle on the robot flange. In this case, the projection of the spindle axis on the coordinate system of the robot flange shall lie only on axis Ox and Oz in the positive direction.
2.) Assemble the cable connectors from the spindle to the milling machine control panel (MM CP) according to the electrical circuit diagram.
3.) Check the compliance of the assembled connector with the diagram using a multimeter.
4.) Connect the spindle and MM CP with the resulting cable.
5.) Fix the cable to the industrial robot body, providing the necessary length margin for free running of the robot units (at the same time, the spare cable shall not interfere with the milling by the spindle).
6.) Install the jig to fix the processed product on the cell work desk according to the equipment layout.
7.) Connect the data cable from MM CP to the robot controller.

The assembled robot-assisted system shall be checked by the Expert when the installation is complete. The Expert shall sign the "Report on Robot-Assisted System Assembly Check" to give authorization for powering up the RAS (see Appendix 1).

Item 2. Voltage supply. End of installation.
1.) Plug in the industrial robot.
2.) Plug in the MM CP.

Item 3. Project uploading, system functional check.
1.) Turn on the laptop and run WorkVisual

2.) Upload the project of the configured cell in the industrial robot controller. The configured project is on the desktop in the "Milling Machine" folder under the name MillingMachineAgilus.

Item 4. Tool and base calibration.
1.) Clamp the milling tool with a 100 mm reach in the spindle grip. The milling tool stickout distance is measured from the end of the holder to the end of the milling tool.
2.) Calibrate the milling tool. Use number 1 for the tool to store the information on the tool calibration. The tool name shall be "Freza100mm". The center of the milling tool end is taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.
3.) Calibrate the tool stroke direction 1 using an additional milling tool with a 50 mm reach.
4.) Calibrate the milling tool with a 50 mm reach. Use number 2 for the tool to store the information on the tool calibration. The tool name shall be "Freza50mm". The center of the milling tool end is taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.
5.) Calibrate the jig base using the "Freza50mm" tool. Take the left-hand corner of the jig nearest to the robot for the origin point. Use number 1 for the base to store the information on the base calibration. The base name shall be "MainBase".

The assembled robot-assisted system shall be checked by the Expert when the installation is complete. The Expert shall sign the "Report on Robot-Assisted System Assembly Check" to give authorization for powering up the RAS (see Appendix 1).

Item 2. Voltage supply. End of installation.
1.) Plug in the industrial robot.
2.) Plug in the MM CP.

Item 3. Project uploading, system functional check.
1.) Turn on the laptop and run WorkVisual
2.) Upload the project of the configured cell in the industrial robot controller. The configured project is on the desktop in the "Milling Machine" folder under the name MillingMachineAgilus.

Item 4. Tool and base calibration.
1.) Clamp the milling tool with a 100 mm reach in the spindle grip. The milling tool stickout distance is measured from the end of the holder to the end of the milling tool.

2.) Calibrate the milling tool. Use number 1 for the tool to store the information on the tool calibration. The tool name shall be "Freza100mm". The center of the milling tool end is taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.

3.) Calibrate the tool stroke direction 1 using an additional milling tool with a 50 mm reach.

4.) Calibrate the milling tool with a 50 mm reach. Use number 2 for the tool to store the information on the tool calibration. The tool name shall be "uFreza50mm". The center of the milling tool end is taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.

5.) Calibrate the jig base using the "Freza50mm" tool. Take the left-hand corner of the jig nearest to the robot as the origin point. Use number 1 for the base to store the information on the base calibration. The base name shall be "MainBase".

Item 5. Writing a spindle control test program.
1.) Create a folder named "MillingTest" in the Program folder to store the first milling program.

2.) Create "SpindelTest" program.

3.) Set the home point. The speed of all PTP movements shall be written in the forms and amount to 10%. The speed of all linear movements shall be written in the form and amount to 0.2 m/s.

4.) Create a program consisting of initial and final PTP home type movement. The program shall also include the spindle switch-on command, a subsequent 40-second hold, and the spindle switch-off command. The PTP home point shall be located in coordinate with the angular values of the robot axes - A1 - 0, A2 - 90, A3 - 90, A4 - 0, A5 -, A6 - 0.

5.) Use the SpindelOn form to turn on the spindle. It is necessary to indicate the rotation speed in the form (to be indicated in rpm).

6.) Use the SpindelOff form to turn off the spindle.

7.) The program shall be tested in T1 mode.

8.) The program shall be tested in T2 mode at a forced reduction of speed by 50%.

9.) The program shall be tested in AUT mode at a forced reduction of speed by 50%.

The spindle can only be driven in AUT mode with the doors closed.

Item 6. Running a milling program.
1.) Place the workpiece in the jig using clamping devices. The workpiece shall be placed according to the model layout on the work desk.

2.) It is necessary to calibrate base number 2 that shall be placed on the surface of the workpiece according to the model layout on the work desk. The base name shall be "ProcessModel".

3.) Transfer the "Model 1" control program from the flash drive to the robot controller to the Program folder.

4.) Ensure that tool number 1 and base number 2 are selected in the control program.

5.) Run the "Model 1" program in AUT mode.

Item 7. Running a milling program.

1.) Save the image of the industrial robot system using Recovery Stick.

2.) To save the image, it is necessary to create a folder named "BackUp …" in the "Milling Machine" folder, where the dots shall be replaced with the industrial robot number.

Module 3. Machine loading/unloading

The competitor shall commission a robotic cell that operates a machine tool. The commissioning works include the following:

1.) Installation.
2.) Voltage supply. End of installation.
3.) Project uploading, system functional check.
4.) Tool and base calibration.
5.) Writing a program.
6.) Saving the image of the configured robotic cell.

Item 1. Installation.

State of the equipment: the equipment is laid out on the table element by element together with fasteners. The robot stands in the training cell, the power and data cables between the robot controller and the industrial robot are connected. The control unit of the industrial robot is also connected.

1.) Install the collision protection on the robot flange.
2.) Install the tool changer system.
3.) Connect the electric gripper to the tool changer.
4.) Connect the pneumatic line to the gripper as per the pneumatic circuit diagram.
5.) Connect the electrical cable from the gripper to the connector on the 4th axis of the robot.
6.) Install the machine tool chuck on the robot's work desk according to the equipment layout.
7.) Connect the pneumatic line to the chuck as per the pneumatic circuit diagram.
8.) Connect the electrical cable from the chuck as per the electrical circuit diagram.
9.) Connect the data cable from the machine tool control panel (MT CP) to the industrial robot controller.
10.) Turn on the compressor and set the outlet pressure to 6 bar.

The assembled robot-assisted system shall be checked by the Expert when the installation is complete. The Expert shall sign the "Report on Robot-Assisted System Assembly Check" to give authorization for powering up the RAS (see Appendix 1).

Item 2. Voltage supply. End of installation.
1.) Plug in the industrial robot.
2.) Plug in the MT CP.

Item 3. Project uploading, system functional check.
1.) Turn on the laptop and run WorkVisual

2.) Upload the project of the configured cell in the industrial robot controller. The configured project is on the desktop in the "Charging Machine" folder under the name CharingMachineAgilus.

Item 4. Tool and base calibration.
1.) Clamp the calibration tool in the electric gripper.
2.) Calibrate the gripper. Use number 1 for the tool to store the information on the tool calibration. The tool name shall be "GEP5006". The pointed end of the calibration tool shall be taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.
3.) Calibrate the chuck base using the "GEP5006" tool. Take the left-hand corner of the chuck nearest to the robot as the origin point. Use number 1 for the base to store the information on the base calibration. The base name shall be "MainBase".
4.) Calibrate the feedstock base using the "GEP5006" tool. Take the left-hand corner of the feedstock nearest to the robot for the origin point. Use number 2 for the base to store the information on the base calibration. The base name shall be "RawStorage".
5.) Calibrate the finished product storage using the "GEP5006" tool. Take the left-hand corner of the finished product storage nearest to the robot as the origin point. Use number 3 for the base to store the information on the base calibration. The base name shall be "ProductStorage".

Item 5. Writing a program.
1.) Create a program named "Charging" in the Program folder. The program is described by the flowchart shown in Figure 1.

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                          ┌─────────┐
                          │  Start  │
                          └─────────┘
                               │
                               ▼
                          ╱─────────╲
                         ╱ Are there  ╲        No
            ┌───────────◄  any more    ►──────────────►  ┌─────┐
            │            ╲ workpieces  ╱                  │ End │
            │             ╲in feedstock╱                  └─────┘
            │              ╲─────────╱
            │                   │ Yes
            │                   ▼
            │      ┌──────────────────────────┐
            │      │ Take the workpiece from   │
            │      │ position n:=n+1            │
            │      │ of the feedstock           │
            │      └──────────────────────────┘
            │                   │
            │                   ▼
            │      ┌──────────────────────────┐
            │      │ Install the workpiece in   │
            │      │ the chuck                  │
            │      └──────────────────────────┘
            │                   │
            │                   ▼
            │      ┌──────────────────────────┐
            │      │ Close the chuck           │
            │      └──────────────────────────┘
            │                   │
            │                   ▼
            │      ┌──────────────────────────┐
            │   ┌─►│ Waiting for completion of  │
            │   │  │ the workpiece machining   │
            │   │  └──────────────────────────┘
            │   │               │
            │   │               ▼
            │   │          ╱─────────╲
            │   │   No    ╱           ╲
            │   └────────◄ Is the      ►
            │            ╲ machining   ╱
            │             ╲complete?  ╱
            │              ╲─────────╱
            │                   │ Yes
            │                   ▼
            │      ┌──────────────────────────┐
            │      │ Grip the finished part.    │
            │      │ Open the chuck            │
            │      └──────────────────────────┘
            │                   │
            │                   ▼
            │      ┌──────────────────────────┐
            │      │ Put the finished part in   │
            └──────┤ the n position:=n+1        │
                   │ of the finished product    │
                   │ storage                    │
                   └──────────────────────────┘
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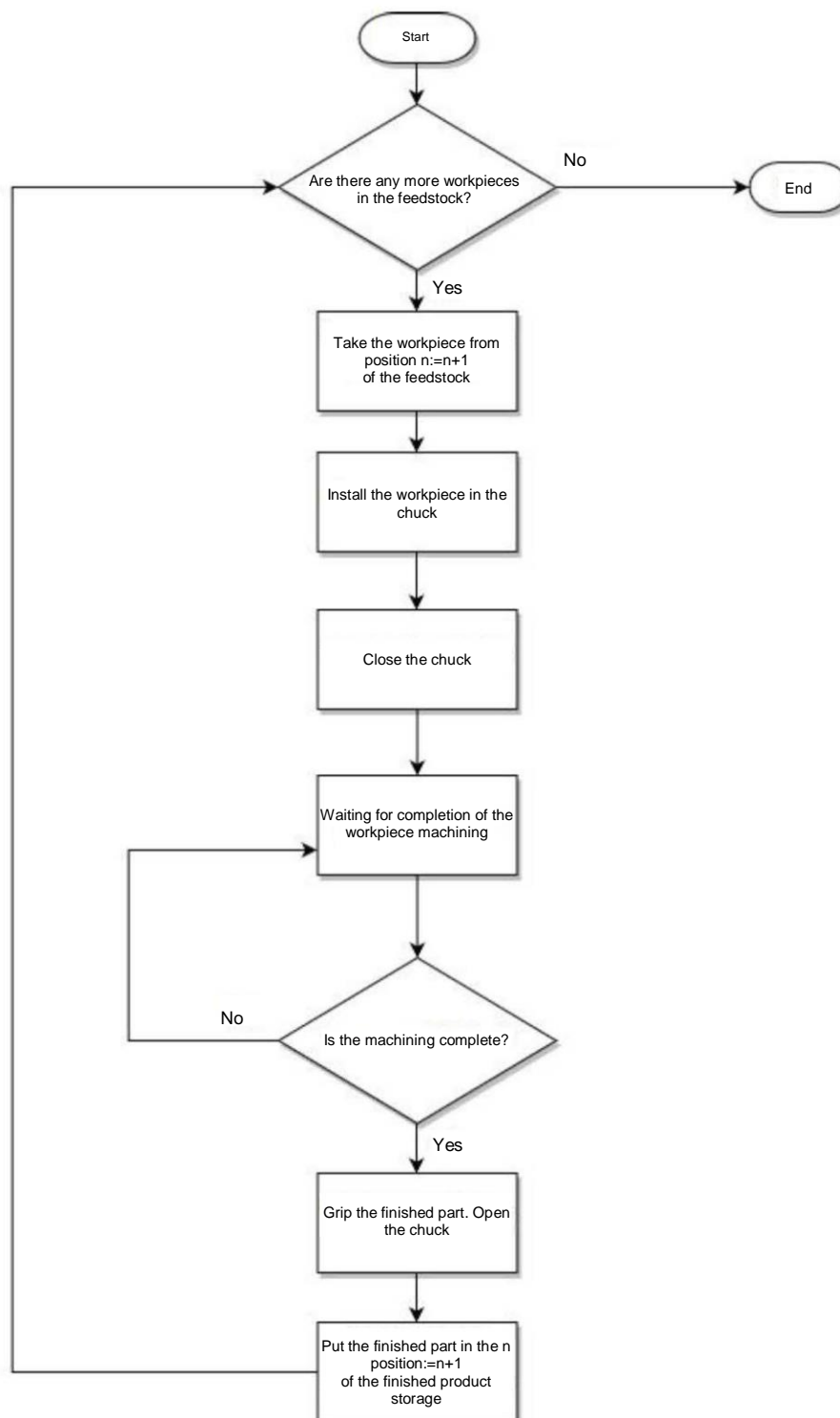
Fig 1. Cycle flowchart of the workpiece machining program

2.) The speed of all PTP movements shall be written in the forms and amount to 10%. The speed of linear movements at a distance over 10 cm between any obstacle and elements of the robot cannot exceed 0.5 m/s and shall be written in the form. The speed of linear movements at a distance less than 10 cm between

any obstacle and elements of the robot cannot exceed OD 5 m/s and shall be written in the form.

3.) All movements belonging to the feedstock and passing the feedstock shall be performed with base number 2 ("RawStorage").

4.) All movements belonging to the chuck and passing the chuck shall be performed with base number 1 ("MainBase").

5.) All movements belonging to the finished product storage and passing the finished product storage shall be performed with base number 3 ("ProductStorage").

6.) The program shall be executed using cycles.

7.) The program shall also run correctly when changing base 2 ("RawStorage") coordinates with base 3 ("ProductStorage") coordinates and base 3 ("ProductStorage") coordinates with base 2 ("RawStorage") coordinates.

8.) The program shall keep count of the parts machined and put in the finished product storage. The variable with this data shall be global and be available to be called from other programs.

9.) The program shall be tested in T1 mode.

10.) The program shall be tested in T2 mode at a forced reduction of speed by 50%.

11.) The program shall be tested in AUT mode at a forced reduction of speed by 50%.

Item 7. Saving the image of the configured robotic cell.

1.) Save the image of the industrial robot system using Recovery Stick.

2.) To save the image, it is necessary to create a folder named "BackUp …" in the "Charging Machine" folder, where the dots shall be replaced with the industrial robot number.

Module 4. Palletizing

The competitor shall commission a robotic cell that performs a palletizing operation. The commissioning works include the following:

1.) Installation.

2.) Voltage supply. End of installation.

3.) Project uploading, system functional check.

4.) Tool and base calibration.

5.) Writing a program.

6.) Saving the image of the configured robotic cell.

Item 1. Installation.

State of the equipment: the equipment is laid out on the table element by element together with fasteners. The robot stands in the training cell, the power and data cables between the robot controller and the industrial robot are connected. The control unit of the industrial robot is also connected.

1.) Install the vacuum gripper on the robot flange.
2.) Connect the pneumatic line to the vacuum gripper as per the pneumatic circuit diagram.
3.) Turn on the compressor and set the outlet pressure to 6 bar.

The assembled robot-assisted system shall be checked by the Expert when the installation is complete. The Expert shall sign the "Report on Robot-Assisted System Assembly Check" to give authorization for powering up the RAS (see Appendix 1).

Item 2. Voltage supply. End of installation.
1.) Plug in the industrial robot.

Item 3. Project uploading, system functional check.
1.) Turn on the laptop and run WorkVisual
2.) Upload the project of the configured cell in the industrial robot controller. The configured project is on the desktop in the "Palletizing Machine" folder under the name PallMachineAgilus.

Item 4. Tool and base calibration.
1.) Calibrate the vacuum gripper. Use number 1 for the tool to store the information on the tool calibration. The tool name shall be "Gripper". The pointed end of the vacuum gripper shall be taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.
2.) Calibrate the pallet 1 base using the "Gripper" tool. Take the left-hand corner of the pallet nearest to the robot as the origin point. Use number 1 for the base to store the information on the base calibration. The base name shall be "Pallet1".
3.) Calibrate the pallet 2 base using the "Gripper" tool. Take the left-hand corner of the pallet nearest to the robot as the origin point. Use number 2 for the base to store the information on the pallet calibration. The base name shall be "Pallet2".
4.) Calibrate the pallet 3 base using the "Gripper" tool. Take the left-hand corner of the pallet nearest to the robot as the origin point. Use number 3 for the base to store the information on the base calibration. The base name shall be "Pallet3".

Item 5. Writing a program.
1.) Create a program named "Palletizing" in the Program folder. The program is described by the flowchart shown in Figure 1.
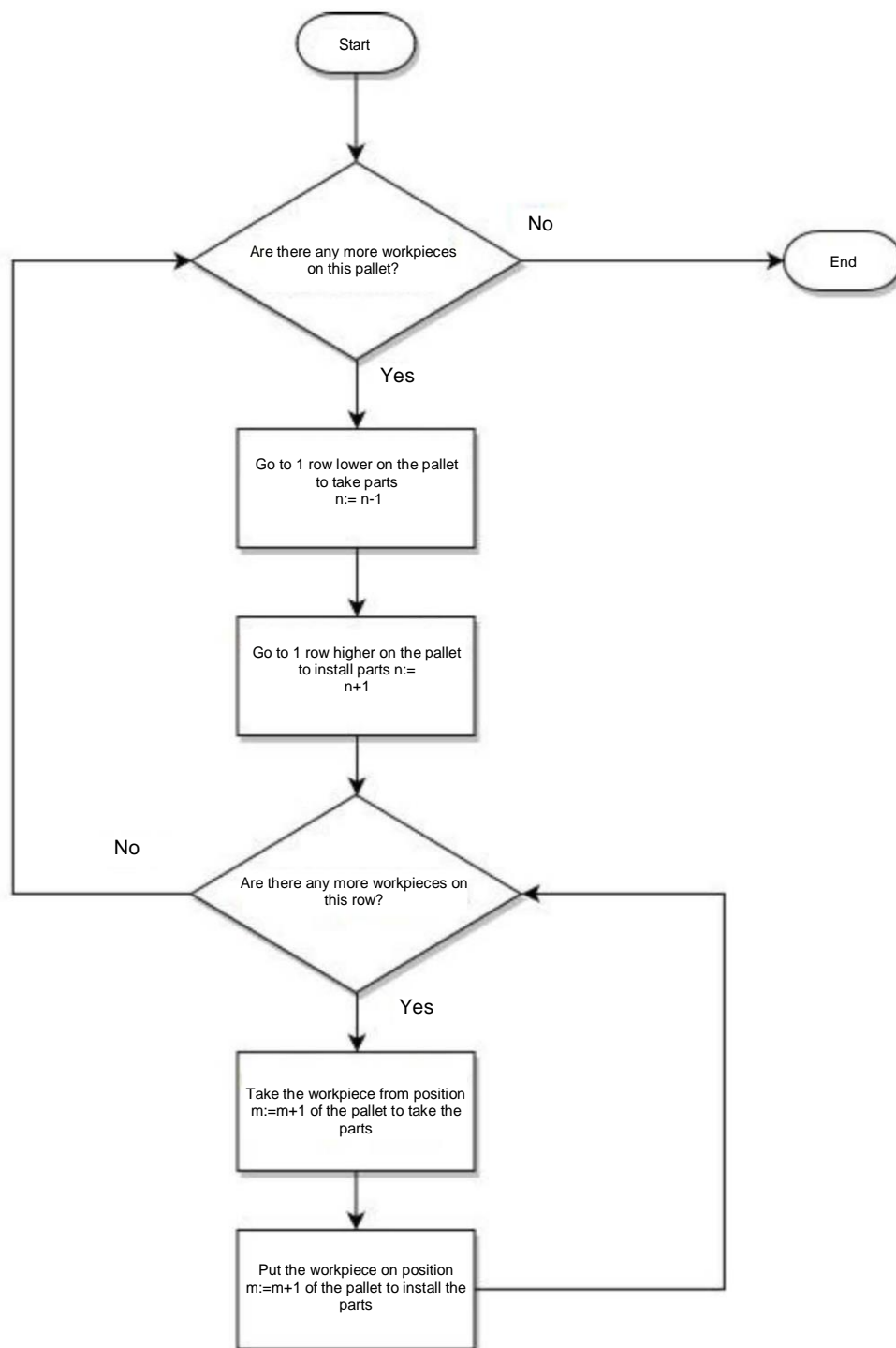

Fig 1. Cycle flowchart of the workpiece palletizing program

1.) The speed of all PTP movements shall be written in the forms and amount to 10%. The speed of linear movements at a distance over 10 cm between any obstacle and elements of the robot cannot exceed 0.5 m/s and shall be written in

the form. The speed of linear movements at a distance less than 10 cm between any obstacle and elements of the robot cannot exceed OD 5 m/s and shall be written in the form.

2.) All movements belonging to pallet 1 and passing pallet 1 shall be performed with base number 1 ("Pallet 1").

3.) All movements belonging to pallet 2 and passing pallet 2 shall be performed with base number 2 ("Pallet2").

4.) All movements belonging to pallet 3 and passing pallet 3 shall be performed with base number 3 ("Pallet 1").

5.) The program shall be executed using cycles.

6.) The program shall also run correctly when changing base 2 ("Pallet2") coordinates with base 3 ("Pallet3") coordinates and base 3 ("Pallet3") coordinates with base 2 ("Pallet2") coordinates.

7.) The program shall keep count of transferred parts. The variable with this data shall be global and be available to be called from other programs.

8.) The program shall be tested in T1 mode.

9.) The program shall be tested in T2 mode at a forced reduction of speed by 50%.

10.) The program shall be tested in AUT mode at a forced reduction of speed by 50%.

Item 6. Saving the image of the configured robotic cell.

1.) Save the image of the industrial robot system using Recovery Stick.

2.) To save the image, it is necessary to create a folder named "BackUp …" in the "Palletizing Machine" folder, where the dots shall be replaced with the industrial robot number.

Module 5. Painting articles

The competitor shall commission a robotic cell that performs an automated operation for painting the article.

The commissioning works include the following:
1.) Installation.
2.) Voltage supply. End of installation.
3.) Project uploading, system functional check.
4.) Tool and base calibration.
5.) Test program for the paint booth.
6.) Program for painting articles.
7.) Saving the image of the configured robotic cell.

Item 1. Installation.

State of the equipment: the equipment is laid out on the table element by element together with fasteners. The robot stands in the training cell, the power and data cables between the robot controller and the industrial robot are connected. The control unit of the industrial robot is also connected.
1.) Install the automated painting device on the robot flange. In this case, the projection of the automated painting device centerline on the coordinate system of the robot flange shall lie only on axis Ox and Ox in the positive direction.
2.) Connect the pneumatic line from the air distributor located inside the robot's brush to the automated painting device as per the pneumatic circuit diagram.
3.) Install the paint booth on the work desk as per the equipment layout.
4.) Connect the signals from the paint booth to the industrial robot controller as per the electrical circuit.

The assembled robot-assisted system shall be checked by the Expert when the installation is complete. The Expert shall sign the "Report on Robot-Assisted System Assembly Check" to give authorization for powering up the RAS (see Appendix 1).

Item 2. Voltage supply. End of installation.
1.) Plug in the industrial robot.
2.) Plug in the paint booth.

Item 3. Project uploading, system functional check.
1.) Turn on the laptop and run WorkVisual
2.) Upload the project of the configured cell in the industrial robot controller. The configured project is on the desktop in the "Painting Robot" folder under the name Painting A gilus.
3.) Turn on the compressor and set the outlet pressure to 1 bar.
4.) Check the positioner rotation inside the paint booth using inputs/outputs.

5.) Enable the display of function keys in the controller menu.
6.) Check that the air supply to the article painting device can be switched on using the function keys. The air supply can only be switched on when crossing the light barrier of the paint booth.

Item 4. Tool and base calibration.
1.) Calibrate the article painting device. Use number 1 for the tool to store the information on the tool calibration. The tool name shall be "Aerograph1". The center point of the outlet nozzle of the article painting device shall be taken as the TCP. The tool calibration tolerance shall be within 0,5 mm.
2.) Calibrate the painting desk base. Take the left-hand corner of the painting desk nearest to the robot as the origin point. Use number 1 for the base to store the information on the base calibration. The base name shall be "MainBase".

Item 5. Test program for the paint booth.
1.) Create a folder for storing additional painting programs with the name "Additional" in the Program folder.
2.) It is necessary to write a program for conducting a functional check of the paint booth positioner. The program name shall be "TestEquipment". The program shall not contain any robot movements. The flowchart of the program is shown in Figure 1.
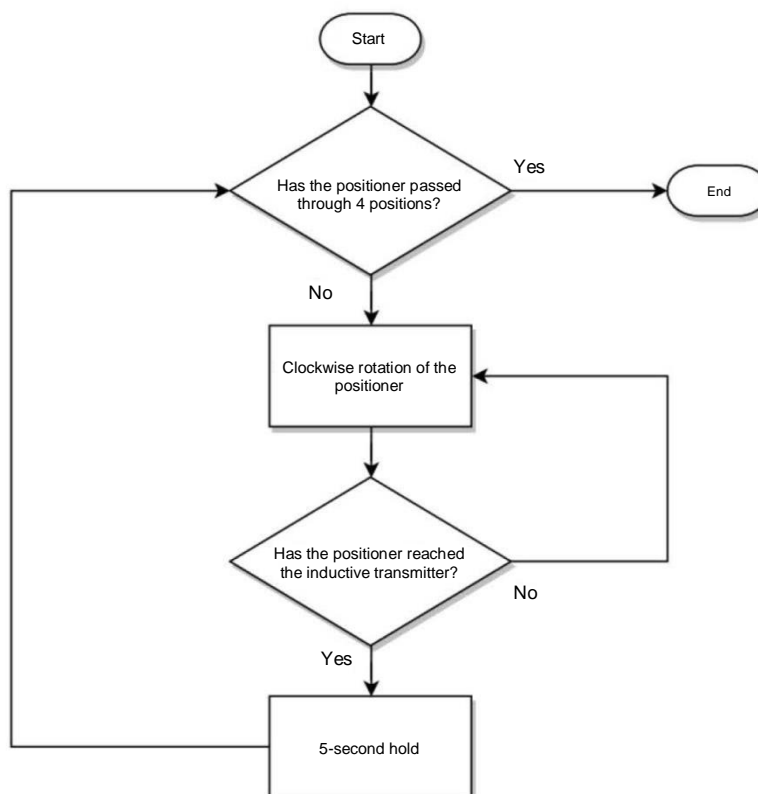
Fig 1. Flowchart of the program for testing paint booth equipment

3.) The program shall be tested in T1 mode.
4.) The program shall be tested in T2 mode.
5.) The program shall be tested in AUT mode.

Item 6. Program for painting articles.
1.) Create a folder named "TypicalPainting" in the Program folder to store the first painting program.
2.) Create the "MyFirstPainting" program.
3.) Write a painting program according to the article submitted. The air supply to the painting device can only be switched on inside the paint booth.
4.) The movement form shall contain the speed of accessing the part and moving away from it to the end point; its value shall be 0.4 m/s. The speed of painting runs can vary between 0.05 m/s and 0.4 m/s. The speed of PTP type movements shall be 20%.
5.) The article shall be painted from all 4 sides. It is necessary to rotate the positioner to paint each side.

Item 7. Saving the image of the configured robotic cell.
1.) Save the image of the industrial robot system using Recovery Stick.
2.) To save the image on the computer, it is necessary to create a folder named "BackUp …" in the "Painting Robot" folder, where the dots shall be replaced with the industrial robot number.

Module 6. Project presentation

The competitor shall develop a robot-assisted system (RAS). It is required to refine the concept and technical aspect, simulate a technical solution in the engineering package, prepare materials, and present the project on automation of the process as specified in the appendix.

This assessment of this module consists of scores for:

1.) Project
2.) Project presentation

The following parameters of the project are assessed:

- Implementation feasibility
- Engineering elaboration of the project
- Scaling possibility of the solution to be implemented
- Application of the existing models of industrial robots and additional equipment

The following parameters of the project presentation are assessed:

- Availability of appropriate photo and video materials
- Availability of handout materials
- Ability to work with an audience
- Execution
- Answers to questions

4. ASSESSMENT CRITERIA

This section defines the assessment criteria and the number of allotted points (subjective and objective), as given in Table 2. The total number of Test Project/module points for all assessment criteria is 100.

Table 2.

Section	Criteria	Assessment		
		Judgment	Measurement	Total
A	Robotic welding	0	16	16
B	Milling	0	16	16
C	Machine loading/unloading	0	16	16
D	Palletizing	0	16	16
E	Painting articles	0	16	16
F	Project presentation	20	0	20
	Total	20	80	100

5. APPENDICES TO THE TEST PROJECT

Appendix 1. Report on assembly check of robot-assisted system

Appendix 1.

Report on Robot-Assisted System Assembly Check

Workstation No./Full name	_____/_____

I hereby confirm that the electrical installation is ready for voltage supply and further operation. All elements of the system are connected in accordance with the wiring diagrams as well as the electrical and pneumatic circuit diagrams.

Attempt 1	Attempt 2	Attempt 3

Expert 1/Full name/Signature	Expert 2/Full name/Signature	Expert 3/Full name/Signature