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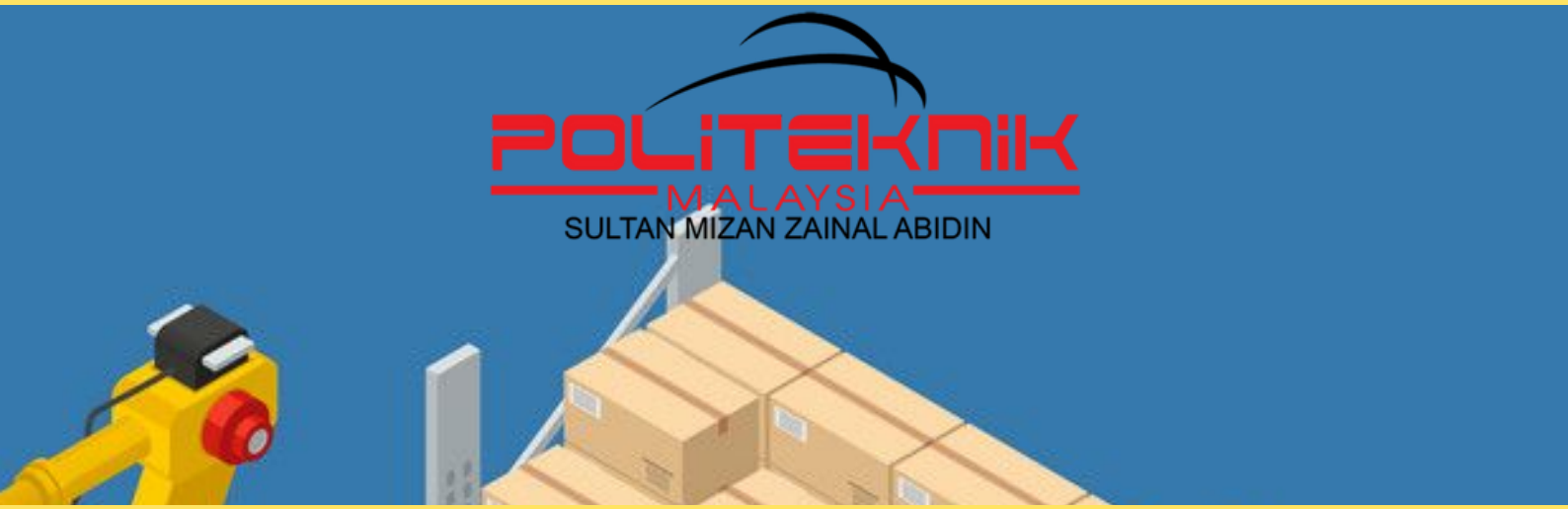
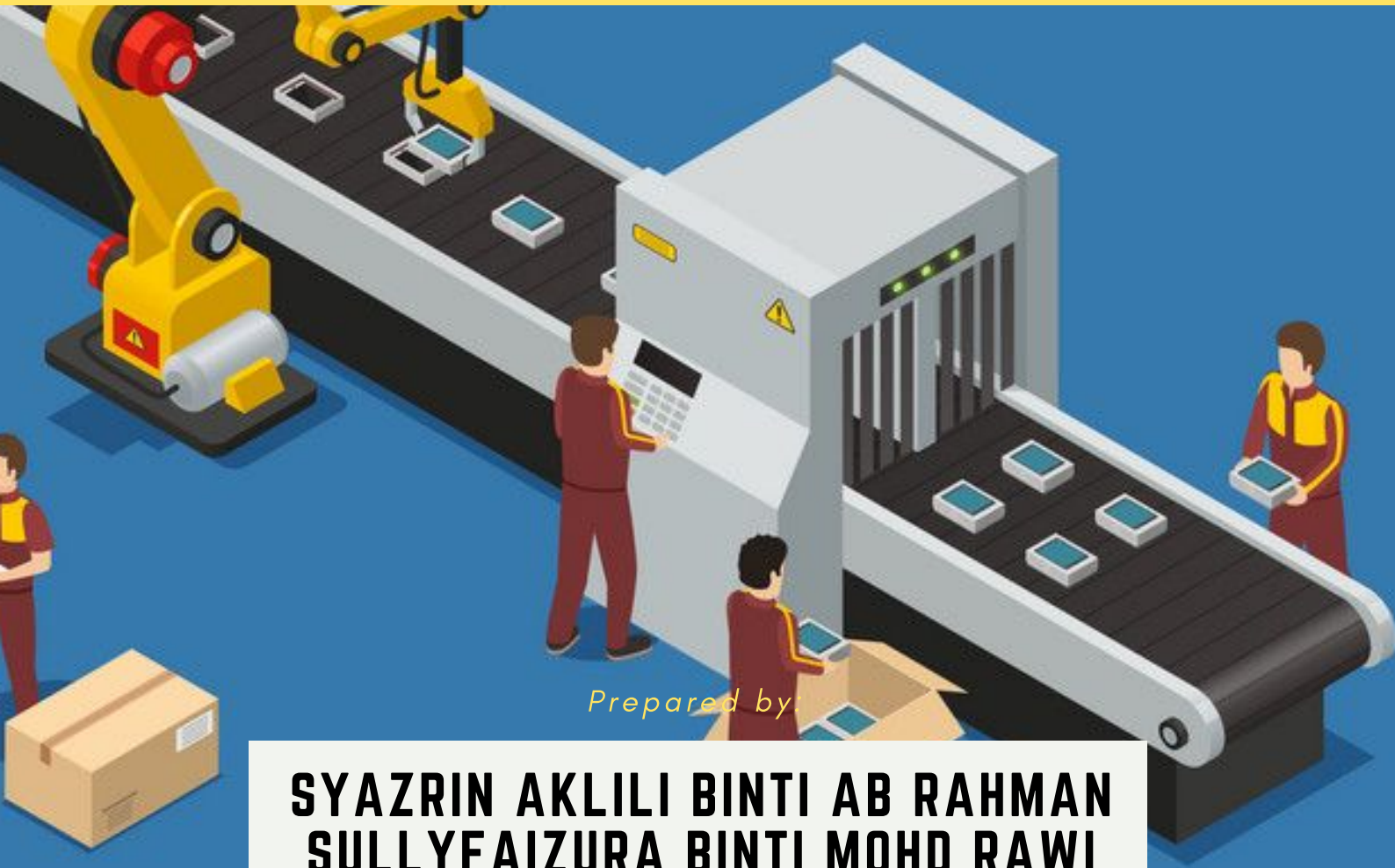


MANUFACTURING WORKSHOP PRACTICE 3 WORKBOOK



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MANUFACTURING WORKSHOP PRACTICE 3 WORKBOOK

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MANUFACTURING WORKSHOP PRACTICE 3

2021 Edition

THE BOOK 'MANUFACTURING WORKSHOP PRACTICE 3 WORKBOOK HAS BEEN DESIGNED TO MEET THE REQUIREMENTS OF LABORATORY PRACTICAL TRAINING FOR THE MANUFACTURING ENGINEERING PROGRAM. THIS BOOK IS ALSO A GUIDE AND GENERAL READING ESPECIALLY FOR LECTURERS AND POLYTECHNICAL STUDENTS IN PARTICULAR.

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ABSTRACT

MANUFACTURING WORKSHOP PRACTICE 3 exposes students to Robot Programming and Application, Programmable Logic Control, Additive Manufacturing, and Plastic Processing in order to build knowledge and abilities in these areas. Robot Application enables students to gain experience with programming, hands-on training, and robot applications. Students will also learn how to utilise a PLC to create a simple programme, which is commonly used in manufacturing and mechanical processes. The focus of Additive Manufacturing will be on creating complicated design shapes, which will entail changing and finalising a prototype's design. The plastic processing process aids students in comprehending the fundamental principles of plastic manufacturing operations.

CONTENTS

1.0

WORKSHOP PROCEDURES AND SAFETY

1.0 PRINCIPLE OF SAFETY IN WORKSHOP

In a workshop, safety is essential because the workshop contains many potential hazards.. If a student uses equipment, tools, or machinery, they should have received safety instruction to ensure that they are confident in their use and can operate machines without injuring themselves or others. Users must comply with a range of risk assessments and safe working procedures, which must be inspected and enforced by the person in charge of these areas. Only authorized workers have access to the workshops because of the high-risk activities that take place there. No one else is permitted to enter the workshops without prior approval. All student who undertakes work in the workshop and laboratories must take reasonable care of their own health and safety of others by following workshop rules.

- Taking action to avoid, eliminated or minimize hazards of which they are aware
- observing all workplace health and safety guidelines, rules, and procedures, including departmental safety manuals;
- Using all safety measures and personal protective equipment as directed;
- Following emergency response personnel's instructions.
- Not putting anyone else's health and safety at risk on purpose
- Maintaining proper clothing standards for the work being done. At all times, appropriate protective gear and footwear must be worn;
- Food and drinks should only be consumed or stored in designated places. In the workshop or any laboratory, food is strictly prohibited.
- Being familiar with emergency and evacuation protocols, as well as the location and usage of emergency equipment if suitably trained;
- All events, risks, and near misses must be reported.

1.1 HOUSEKEEPING SAFETY RULES

The basic upkeep, tidiness, and maintenance of a safe laboratory are covered by laboratory housekeeping guidelines, which apply to all institutions. Everyone is responsible for housekeeping.

- Keep your work area(s) tidy and clean at all times. The floors must be kept neat and clean.
- Only keep the materials you need for your work in your work space.
- Obstacles must be kept out of the aisles and exits
- All emergency equipment (fire extinguishers, first aid kits) must have unrestricted access.
- Work areas and equipment must be cleaned completely after each usage.
- Before leaving the laboratory, ensure that all equipment is turned off.

1.2 FIRE EXTENGUISHERS

This equipment is only available in the workshop to put out minor fires. The building should be evacuated if the fire represents a danger. Before using a fire extinguisher, read the instructions to be sure it was the right one for the purpose.

2.0

LABSHEET

LABSHEET

A. PROGRAMABLE LOGIC CONTROL (PLC)
B. ADDITIVE MANUFACTURING
C. ROBOT PROGRAMMING AND APPLICATION
D. PLASTIC PROCESSING

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**BASIC PROGRAMMABLE LOGIC CONTROLLER (PLC)**
DURATION	**:**	**4 HOURS PER WEEK**

1.0 OBJECTIVES

1.1 Describe the general structure and role of a PLC in an automated system

1.2 Read, develop, write, and test basic PLC program in ladder language and mnemonic code.

2.0 THEORY

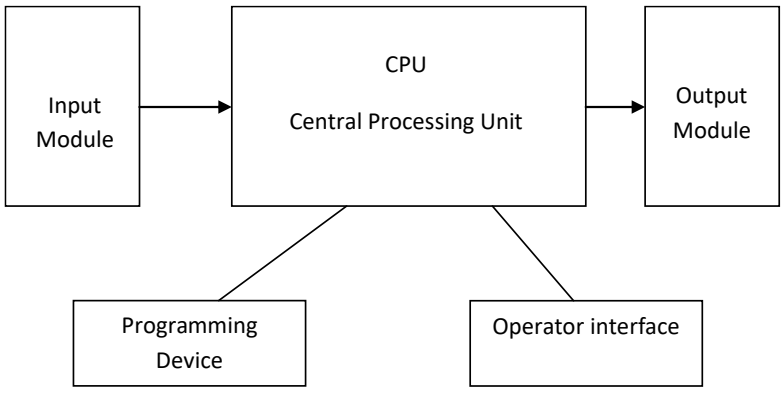
A ***programmable Logic Controller (PLC)***, also referred to as ***programmable controller***, is primarily used to control machinery. A program is written for the PLC which turns on and off outputs based on input conditions and the internal program. In this aspect, a PLC is similar to a computer. However, a PLC is designed to be programmed once, and run repeatedly as needed. In fact, a crafty programmer could use a PLC to control not only simple devices such as a garage door opener, but their whole house, including turning lights on and off at certain times, monitoring a custom built security system, etc. Most commonly, a PLC is found inside of a machine in an industrial environment. A PLC can run an automatic machine for years with little human intervention. They are designed to withstand most harsh environments a PLC will encounter.

NEMA, *the National Electrical Manufactures Association, defines a programmable logic controller (PLC) as:*

A programmable controller is a digitally operating electronic apparatus which uses a programmable memory for the internal storage of instruction for implementing specific functions, such as logic, sequence, timing, counting and arithmetic, to control through digital or analog input/output, various types of machine or process.

3.0 MATERIALS AND EQUIPMENT:

The basic components in PLC system are:



3.1 Input and output interfaces to provide connectivity or communication with industrial equipment to be controlled.

3.2 Central Processing Unit (CPU), this is a micro-processing system which is capable of performing all the decision making, logic and mathematical functions and also supervise all the input and output signals.

3.3 Memory, a place where all program saved.

3.4 Power supply, provides the voltage needed to run the primary PLC components.

3.5 Programming device, used to enter the desired program that will determine the sequence of operation and control of process equipment or driven machine.

Table 1: Input and Output device

INPUT	CONTROLLER	OUTPUT
Selector Switches	Relays	Alarm
Pushbuttons	Timers	Fan
Photoelectric Switches	Counters	Lights
Limit Switches	Control Relays	Valves

PLC programming Languages

i. Ladder Diagram
ii. Function Block Diagram / FBD
iii. Instruction List / IL
iv. Structured Text / ST
v. Sequential Function Chart /SFC

THE COMMAND KEYS

FUN — Numerous special application commands called FUNctions may be

LD — LoaDs input points into the program and provides a means of branching points

AND — AND allows additional points to be connected together, to form a series

O — OR allows points to be joined to the circuits in such a way that allows parallel connections.

OU — The output

TIM — The timers are controlled using this command.

CNT — The counters are controlled using this command

NOT — Used with LD, AND and OR command keys to designate NC (normally

HR — Designates Holding Relays.

TR — Designates Temporary Relays.

SFT — Display the operations of the SHIFT register.

SHIFT — SHIFT is used to obtain the alternate function of the four keys with more than one use, labelled,

0 — When inputting decimal or hexadecimal numbers when programming.

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4.0 SAFETY PRECAUTIONS

It is the individual's responsibility to practice the following general safety guidelines at all times and keep your workspace reasonably tidy:

4.1 Always know the hazards associated with the equipment/materials that are being utilized in the workshop.

4.2 Be familiar with the location of emergency equipment such as fire alarm and fire extinguisher. Know the appropriate emergency response procedures.

5.0 PROCEDURES

5.1 To delete a command **<PROGRAM> PASSWORD!** Is to press key **CLR MONTR CLR**.

5.2 To delete the previous program is by pressing the **CLR MONTR CLR SET NOT RESET MONTR CLR.**

5.3 To enter the program, make sure the mode selector switch in the Programming Console is in PROGRAM mode.

5.4 To execute the program that has stored in the PLC, set the mode Selector switch to RUN or MONITOR mode.

5.5 To look back on programs that have been entered, press the CLR button and arrows ↓ or ↑ view the program.

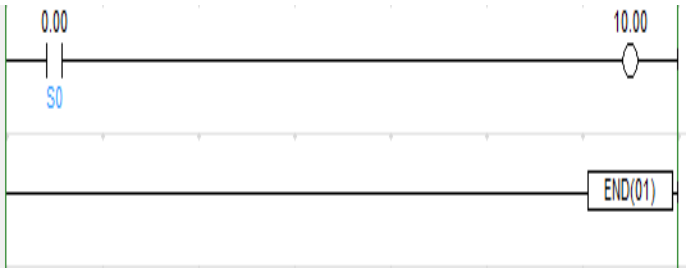
5.6 To INSERT an instruction, display the instruction before which you want the new instruction to be placed, input the instruction in the same way as when inputting a program initially, and the press INS and the ↓ key.

5.7 To delete an instruction, find an instruction and then press the button DEL and the ↑ key.

5.8 To view the status of the INPUT or OUTPUT inserted, turn the mode selector switch to MONITOR mode and then enter the CLR SHIFT, INP or OUT number to be viewed and then press MONTR.

EXAMPLE 1

Switch **00** is used to switch on **OUTPUT 1000**

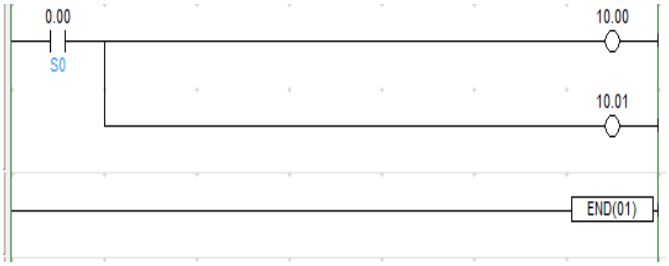


Instruction list (Mnemonic codes)

Address	Instruction	Data
0000	LD	0000
0001	OUT	1000
0002	END(01)	

EXAMPLE 2

Switch **00** is used to switch on two different **OUTPUTS**, **1000** and **1001**.

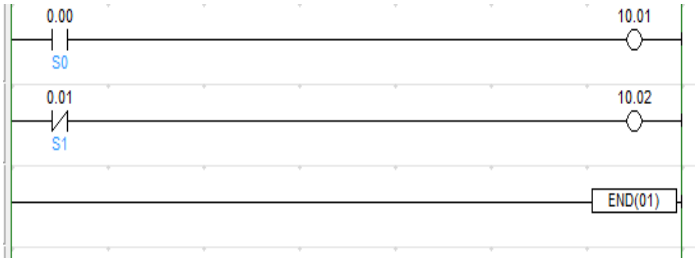


Instruction list (Mnemonic codes)

Address	Instruction	Data
0000	LD	0000
0001	OUT	1000
0002	OUT	1001
0003	END (01)	

EXAMPLE 3

OUTPUT 1001 activated when **switch 00** is on, while **OUTPUT 1002** is de-activated when **switch 01** is on.

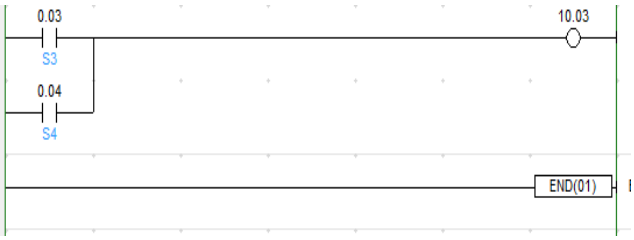


Instruction list (Mnemonic codes)

Address	Instruction	Data
0000	LD	0000
0001	OUT	1001
0002	LD NOT	0001
0003	OUT	1002
0004	END (01)	

EXAMPLE 4

OUTPUT 1003 is activated either by switching on switch **03 OR** switch **04**.

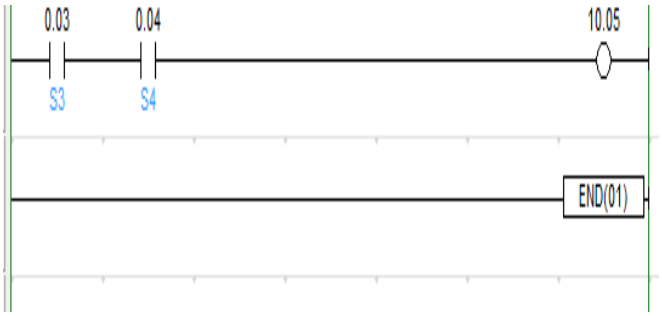


Instruction list (Mnemonic codes)

Address	Instruction	Data
0000	LD	0003
0001	OR	0004
0002	OUT	1003
0003	END (01)	

EXAMPLE 5

OUTPUT 1005 can be activated by switching on switch **03 AND** switch **04**.



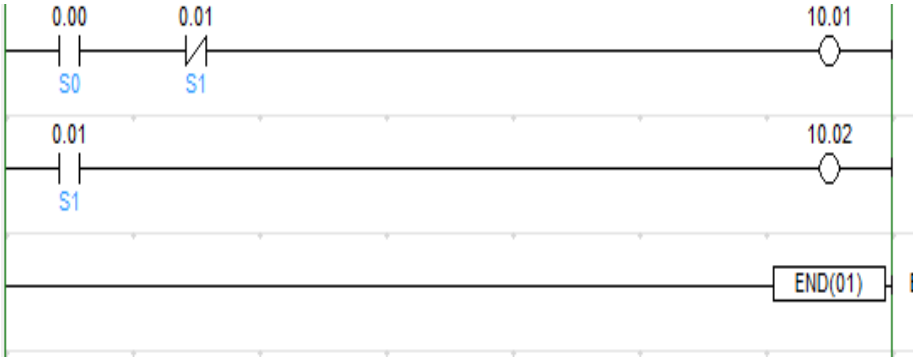
Instruction list (Mnemonic codes)

Address	Instruction	Data
0000	LD	0003
0001	AND	0004
0002	OUT	1005
0003	END (01)	

6.0 TASK/EXERCISE

EXERCISES 1

By transferring the ladder diagram into mnemonic code, explain what happen to the **OUTPUT 1001** and **OUTPUT 1002** by filling the table given.



Instruction list (Mnemonic code)

INPUT		OUTPUT	
S 00	**S 01**	**1001**	**1002**
OFF	**OFF**		
ON	**OFF**		
OFF	**ON**		
ON	**ON**		

Address	Instruction	Data
0000		
0001		
0002		
0003		
0004		
0005		
0006		
0007		
0008		

EXERCISES 2

OUTPUT 1003 can be activated by the following methods:

a) Switching on **00** AND switching off **01**, OR,
b) Switching on **02** only

Draw the ladder diagram and the mnemonic code for the above problem.

Instruction list (Mnemonic codes) **Ladder Diagram**

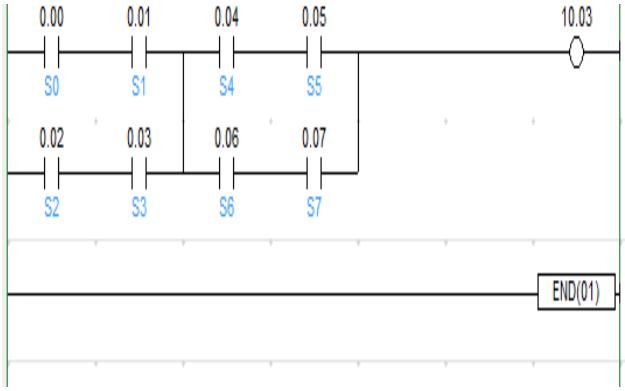
ADDRESS	INSTRUCTION	DATA
0000		
0001		
0002		
0003		
0004		
0005		
0006		
0007		
0008		
0009		

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**BASIC PROGRAMMABLE LOGIC CONTROLLER (PLC)**
DURATION	**:**	**4 HOURS PER WEEK**

EXERCISES 3

Transfer the following ladder diagram into their respective mnemonic codes.

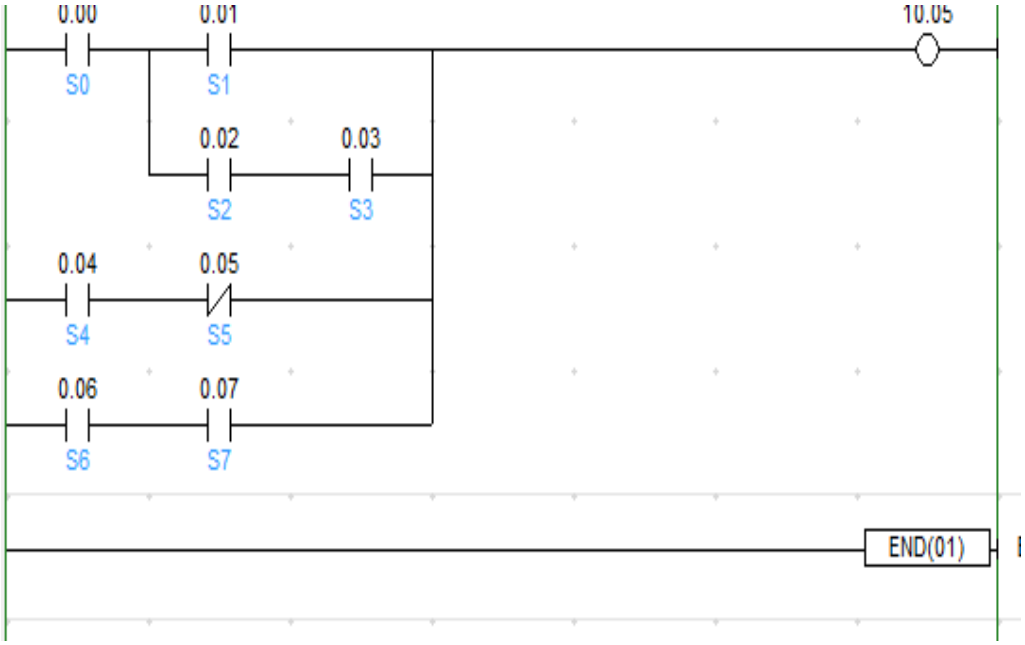
a)



Instruction list (Mnemonic codes)

Address	Instruction	Data
0000		
0001		
0002		
0003		
0004		
0005		
0006		
0007		
0008		
0009		
0010		
0011		
0012		
0013		
0014		
0015		
0016		
0017		

b)



Instruction list (Mnemonic codes)

ADDRESS	INSTRUCTION	DATA
0000		
0001		
0002		
0003		
0004		
0005		
0006		
0007		
0008		
0009		
0010		
0011		
0012		
0013		
0014		
0015		
0016		

7.0 RESULT/DATA

7.1 Answer exercise 1 – 3

8.0 DISCUSSION

Based on Result/Data and analyze your result.

9.0 CONCLUSION AND RECOMMENDATION

Your conclusion should be related to your practical and theoretical understanding on the related topic.

10.0 REFERENCES

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**ADDITIVE MANUFACTURING**
DURATION	**:**	**4 HOURS PER WEEK**

1.0 OBJECTIVE

Conduct the additive manufacturing design process by following:

1.1 Identify standard additive manufacturing equipment

1.2 Apply the procedure of design process to create complex shape

1.3 Accomplish a prototype of one design using additive manufacturing machine

2.0 THEORY

The term additive manufacturing refers to a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data. These "three dimensional printers" allow designers to quickly create tangible prototypes of their designs, rather than just two-dimensional pictures. Such models have numerous uses. They make excellent visual aids for communicating ideas with co-workers or customers. In addition, prototypes can be used for design testing. For example, an aerospace engineer might mount a model airfoil in a wind tunnel to measure lift and drag forces. Designers have always utilized prototypes; additive manufacturing allows them to be made faster and less expensively. There are many types of technology 3D printing machine among them are Stereolithography (SLA), Fused deposition Modeling (FDM), Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electronic Beam Melting (EBM), Laminated Object Manufacturing (LOM), Binder Jetting (BJ), Material Jetting (MJ), Digital Light Processing (DLP), Solid Ground Curing (SGC) and many more.

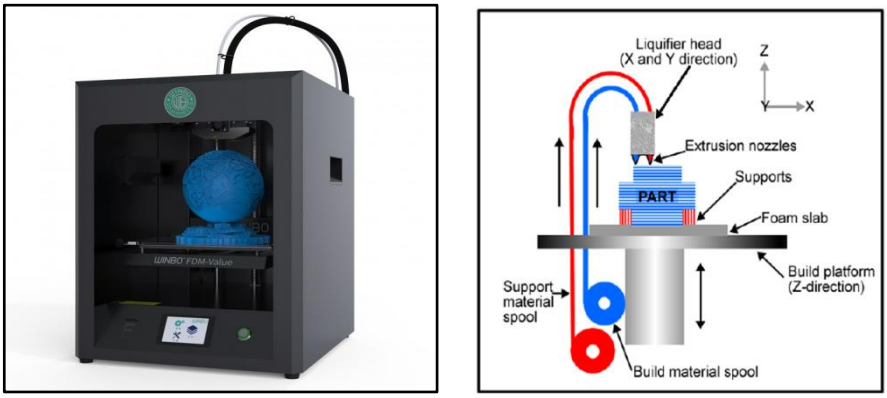


Figure 1: Fused Deposition Modeling (FDM)machine

3.0 MATERIALS AND EQUIPMENT

Computer with CAD program, 3D printing machine, plastic material filament etc.

4.0 SAFETY PRECAUTIONS

It is the individual's responsibility to practice the following general safety guidelines at all times and keep your workspace reasonably tidy:

4.1 Always know the hazards associated with the equipment/materials that are being utilized in the workshop. Be careful with hot nozzle of RP machine.

4.2 Always wear appropriate protective clothing and equipment.

4.3 Confine long hair and loose clothing. Do not wear high-heeled shoes, open-toed shoes, sandals or shoes made of woven material.

4.4 Be familiar with the location of emergency equipment such as fire alarm and fire extinguisher. Know the appropriate emergency response procedures.

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**ADDITIVE MANUFACTURING**
DURATION	**:**	**4 HOURS PER WEEK**

5.0 PROCEDURES

5.1 Design a product in 3D by using CAD software
5.2 Convert file 3D CAD model to stl format
5.3 Insert file stl into rapid prototype machine software
5.4 Check 3D printer machine equipment and material
5.5 Setup a machine and printing properties to build up a prototype
5.6 Start to make a rapid prototype
5.7 Wait until process finish
5.8 Take out model carefully
5.9 Clean and finishing rapid prototype product.

6.0 RESULT/DATA

6.1 Scale of prototype from original size
6.2 Layer high
6.3 Total of layer
6.4 Temperature of nozzle and platform
6.5 Raft and support
6.6 Built time
6.7 3D CAD with the dimension in title block.
6.8 Show final prototype
6.9 Review –shape, defect, temperature, etc

7.0 DISCUSSION

7.1 What is additive manufacturing?
7.2 What is requirement to be provided before the prototype can be built?
7.3 Why additive manufacturing is needed in the manufacturing industry?
7.4 What are the advantages and disadvantages of additive manufacturing?
7.5 Briefly explain the construction process of prototype through the FDM 3D printing machine with the aid of a diagram.
7.6 What do you get from this laboratory and why it's important to learn about the additive manufacturing?

8.0 CONCLUSION AND RECOMMENDATION

Your conclusion should be related to your practical and theoretical understanding on the related topic.

9.0 REFERENCES

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**BASIC PROGRAMMING ROBOT ARM**
DURATION	**:**	**4 HOURS PER WEEK**

1.0 OBJECTIVE

1.1 Define some terms of command functions

1.2 Know how to construct a program using MELFA BASIC and solve some simple problems. .

2.0 THEORY

2.1 Teach points (TP's) define target positions for the robot

Figure 1: RV2AJ Arm Robot

A Teach point for the RV-2AJ robot consists of 5 values, namely:

1. Cartesian X position
2. Cartesian Y position
3. Cartesian Z position
4. A – wrist rotation A
5. B – wrist rotation B

Hence the Mitsubishi RV-2AJ robot has only 5 degrees of freedom. We know that in general to both position (x, y, z) and orientate (roll, pitch, yaw) an object in space requires SIX degrees of freedom. Therefore this robot, in common with many other industrial robots, has reduced functionality. In practice this does not seriously limit it's the range of its application.

2.2 The COSIMIR® Robotics Concept

2.2.1 The position list

Now that you've brought the robot into a position from which it can grasp the workpiece with its gripper, you can save this point to the position list. The position list contains all of the points to which the robot must move directly for a given program, as well as important ancillary points for moving along a path (mid-point, diverging point etc.).

Why is a position list so important? One could argue that as long as the cell is known, any desired point can be calculated. Why, then, should the robot first move to

certain teaching points? The answer is quite simple: As a rule, industrial robots demonstrate very good repetition accuracy, but their absolute positioning accuracy is entirely inadequate for most applications.

Further details are included in the Robotics Assistant. One of the main tasks during commissioning of a robotics application is testing the position list, i.e. positions established in the simulation are tested via the real system, and are modified if necessary. It is thus extremely important for trainees to become well acquainted with the teach-in procedure in the simulation. Each workcell has its own position list which you can take advantage of in order to reduce the time required for teaching in all of the positions.

2.3 The first robot program

As is also the case with the teach-in procedure, two different types of motion commands are also used for programming robot motion:

i. Movement from a starting point to an end point, which is known as point-to-point movement (abbreviated PTP). The actual path to the robot's end point is not defined, because all axes travel to their endpositions independent of one another.

ii. Movement of the robot to the end point via a predefined path (for example along a straight line).

2.4 Introduction to MELFA-BASIC

Table 1: Command, Explanation and Example

COMMAND	EXPLANATION	EXAMPLE
MOV	Moves the robot to a teach-point position	MOV P1
MVS	Moves the robot to a teach-point in a straight line	MVS P1
	Moves the robot to a position above the teach-point in a straight line. (Z-Axis distance in Tool-frame)	MVS P1, -50
OVRD	Override speed limit (0 to 100%) (never use more than 30 for safety ! make this the first line of your program)	OVRD 20
DLY	Delay in seconds – Robot waits	DLY 0.5
HOPEN	Opens the gripper	HOPEN 1
HCLOSE	Closes the gripper	HCLOSE 1
GOSUB	Calls a subroutine	GOSUB *PICK
RETURN	Returns from the subroutine	RETURN
DEF POS	Defines a position variable	DEF POS PTMP
END	End of program	END

2.5 Example programs:

2.5.1 Placing of an object

Table 2: The example program Pr1 puts down an object at position P10:

```
10  OVRD 20              'set speed to 20%
20  MOV P10, -50         'go within 50mm of teach-point P10
30  OVRD 5               'set speed to 5%
40  MVS P10              'go to P10
50  DLY 0.5              'wait 0.5 seconds to make sure the robot
stopped
60  HOPEN 1              'open gripper
70  DLY 0.5              'wait 0.5 seconds
80  OVRD 20              'set speed to 20%
90  MVS P10, -50         'move up, to leave position P10
100 END                  'end of program
```

As shown in the program Pr1 a good program should consider the following:

a. use as few teach-points as possible
b. Always use an approach point before going to the target point

To ensure you are not hitting the target from the wrong direction

a. use delays to let the robot settle
b. set the speed limit appropriately

When using the interpolation move MVS, the robot sometimes cannot create an interpolation path and returns with an out of range error. Use MOV instead of MVS when moving between approach points.

3.0 MATERIALS AND EQUIPMENT

3.1 MELFA BASIC Programming

4.0 SAFETY PRECAUTIONS

The following safety rules must ALWAYS be obeyed.

4.1 **NEVER enter the robot work space when servo power is on!**
i.e., the green LED (light emitting diode) at the “SVO ON” switch is on.

4.2 Always make sure there is no one in the work cell before starting a program.

4.3 Always give an audible warning before running the program.

4.4 Always keep one hand at the emergency stop and observe the robot during its full operational cycle

4.5 Always write “OVRD 20” as the first line in any robot program. This limits the maximum speed

4.6 Never load the robot with more than 2 kg. If the arm is operated at full stretch limit the maximum load to 0.5 kg.

4.7 Never leave the robot unattended when it is powered up.

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**BASIC PROGRAMMING ROBOT ARM**
DURATION	**:**	**4 HOURS PER WEEK**

5.0 PROCEDURES

5.1 Operational rules

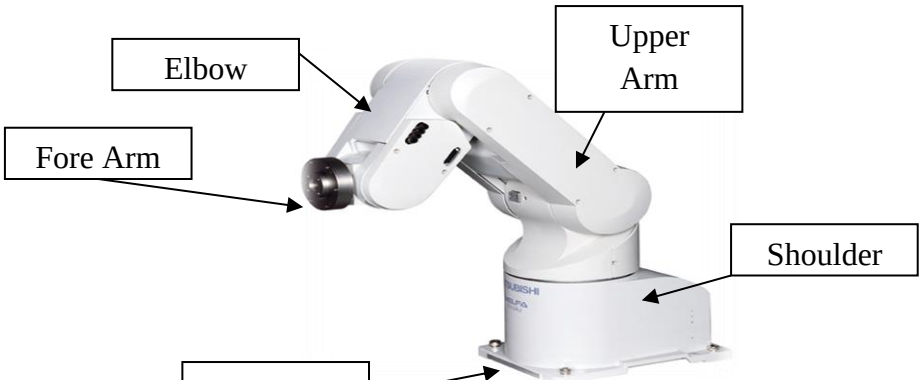
In order to prevent damage to the robot:

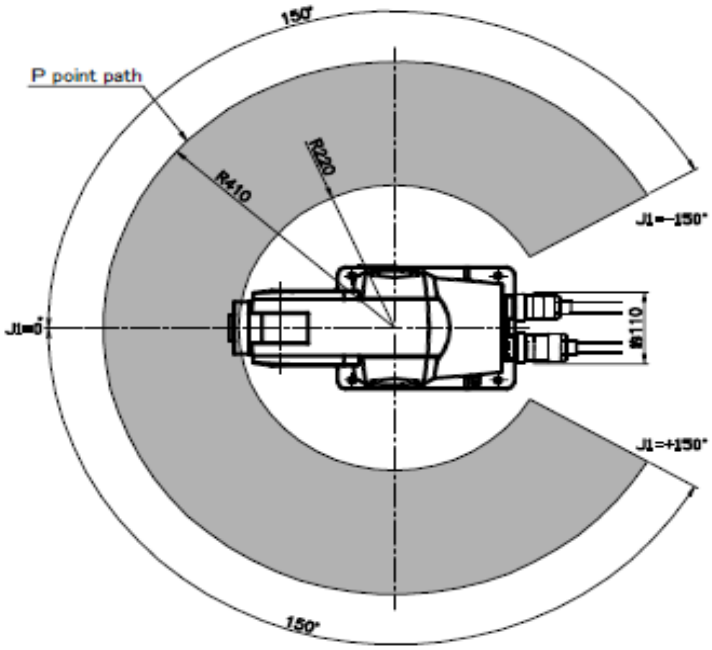
i. Do not switch off the controller power while the robot has power on the servo
ii. Avoid collisions. If you think the robot will cause a collision press the emergency stop button immediately.
iii. Do not change the tool-end coordinates

5.2 Operation modes

Identify the four parts of the robot system, namely;

1. The Mitsubishi RV-2AJ robot arm
2. The robot controller
3. A Teach Pendant (or TeachBox).
4. The PC





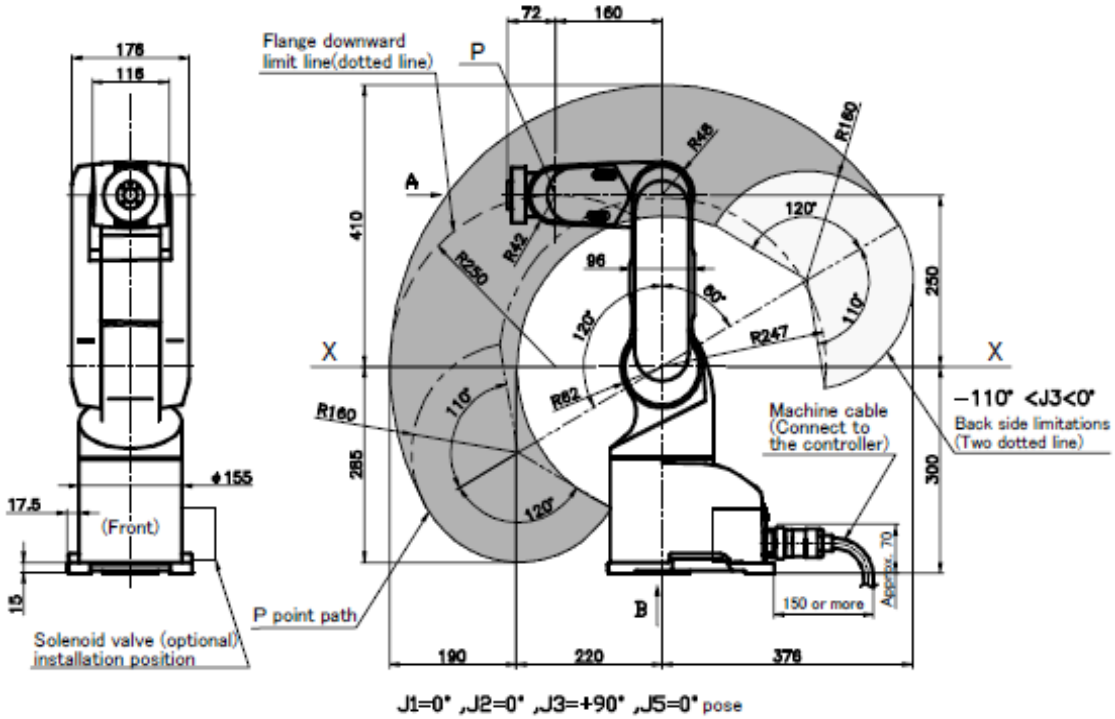


Figure 2: RV2AJ Arm Robot : DOF

5.2.1 JOG OPERATION

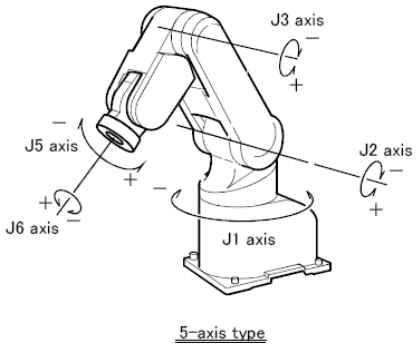


Figure 3: JOINT jog operation

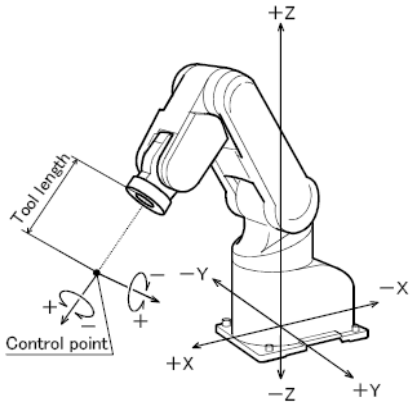


Figure 4: XYZ jog operation

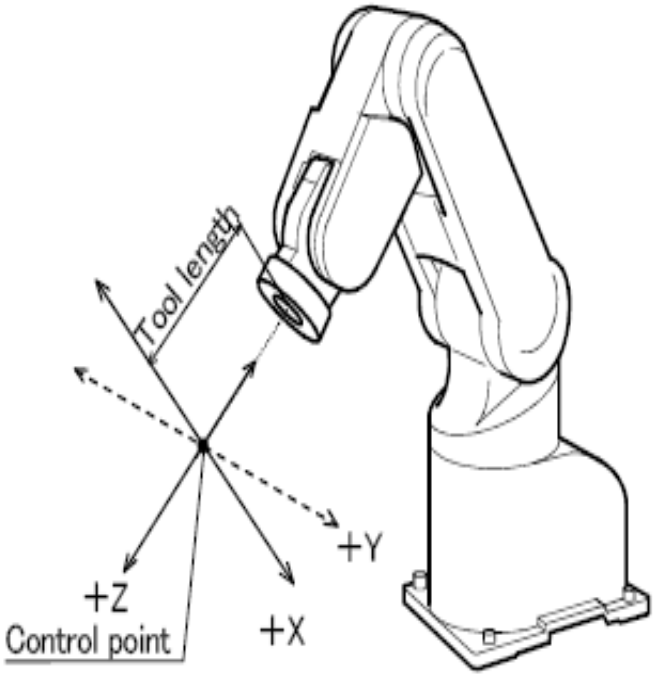


Figure 5: TOOL jog operation

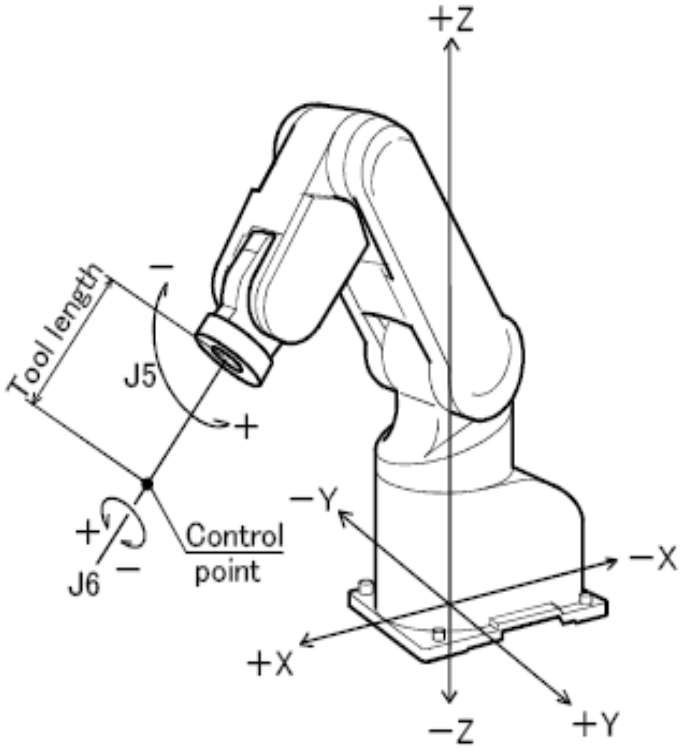
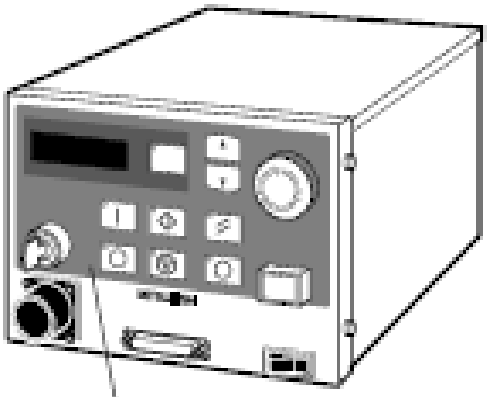


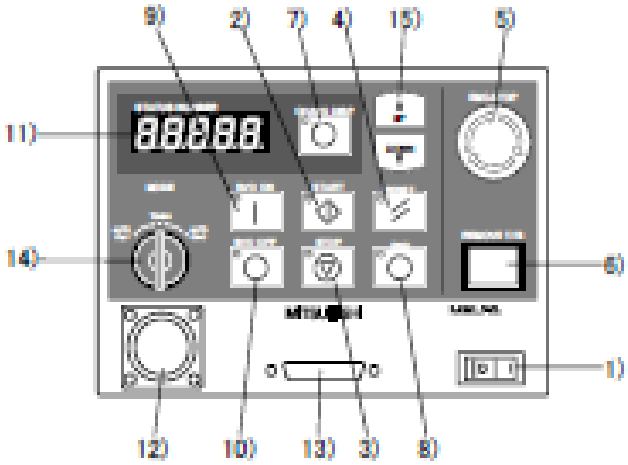
Figure 6: 3-axis XYZ jog operation

5.2.2 CONTROLLER CR1

<Front>



<Front side of operation panel>



1) POWER switch ..... This turns the control power ON/OFF.
2) START button ..... This executes the program and operates the robot. The program is run continuously.
3) STOP button..... . This stops the robot immediately. The servo does not turn OFF.
4) RESET button.....This resets the error. This also resets the program's halted state and resets the program.
5) Emergency stop switch ...This stops the robot in an emergency state. The servo turns OFF.
6) T/B remove switch .....This is used to connect/disconnect the T/B without turning OFF the controller's control power.
7) CHNGDISP button..... This changes the details displayed on the display panel in the order of "Override" → "Program No." → "Line No.".
8) END button..... This stops the program being executed at the last line or END statement.
9) SVO.ON button..... This turns ON the servo power. (The servo turns ON.)
10) SVO.OFF button ..... This turns OFF the servo power. (The servo turns OFF.)
11) STATUS NUMBER (display panel)... .The alarm No., program No., override value (%), etc., are displayed.
12) T/B connection connector .....This is a dedicated connector for connecting the T/B.
13) Personal computer connection connector .....This is an RS-232C specification connector for connecting the personal computer.
14) MODE key switch .....This changes the robot's operation mode.
AUTO (Op.).....Only operations from the controller are valid. Operations for which the operation mode must be at the external device or T/B are not possible.
TEACH..... ..When the T/B is valid, only operations from the T/B are valid. Operations for which the operation mode must be at the external device or controller are not possible.
AUTO (Ext.)..... Only operations from the external device are valid. Operations for which the operation mode must be at the T/B or controller are not possible.
15) UP/DOWN button .....This scrolls up or down the details displayed on the "STATUS. NUMBER" display panel.

5.2.3 COMMON ERROR MESSAGES

When an error occurs the controller will beep. To recover from an error press the reset button on the teach pendant or on the robot controller. If the emergency stop button was pushed, it must be pulled out before pressing reset.

In some cases an error a code will appear on the screen. Common error codes are listed below:

Table 3: Code and meaning

Code	Meaning
L2800 – L2803	position data is inadequate. *****
L2600 – L2603	position is out of range *****
H0060	Emergency Stop on controller was pushed
H0070	Emergency Stop on T/B was pushed
H5000	The T/B Enable key was validated in the automatic mode.
H1010	Collision
C1350	Overload (possibly Collision)
C4340	Variable not defined (you forgot DEF POS or you forgot to download the teach-point file)

If the code is not listed please consult [2].

***** On an error message while trying to go to a pre-programmed teach point there several possible causes:

- The target position is outside the robots workspace (joint reaches the limit while trying to reach the target position). Try adjusting the target position slightly. A fraction of a millimetre can be enough.
- the teach point file (.POS) is corrupt.
  Edit the .POS file with MS Notepad (not RoboExplorer!) and confirm that the last bracket of each position is (6,0) and not (0,0)
- An interpolation or inverse kinematics error can occur if you use MVS (move linear) commands and a calculated target position rather than a learned teach-point. Also avoid angles at exactly -/+180.0°.

Table 4: Working Envelope Limits

Joint space limits: **Joint**	**Limit**
J1	-150° to +150°
J2	- 60° to +120°
J3	-110° to +120°
J5	- 90° to + 90°
J6	-200° to +200°

5.2.4 Detailed specifications of MELFA-BASIC IV

In this section, detailed explanations of the MELFA-BASIC IV format and syntax such as configuration are given, as well as details on the functions of each command word. The following explains the components that constitute a statement.

(1) Program name

A program name can be specified using up to 12 characters. However, the operation panel display can display only up to four characters; it is therefore recommended to specify the program name using up to four characters. Moreover, the characters that may be used are as follows.

If a program name is specified using more than four characters, the program cannot be selected from the operation panel. In addition, if it is desired to use an external output signal to select a program to be executed, the program name should be specified using the numbers.

(2) Command statement

Example of constructing a statement

```
10      MOV   P1      WTH M_OUT(17)=1
(1)      (2)   (3)              (4)
```

1) Line No. : Numbers for determining the order of execution within the program.
Lines are executed in ascending order.

2) Command word: Instructions for specifying the robot's movement and tasks

3) Data: Variables and numerical data necessary for each instruction

4) Appended statement: Specify these as necessary when adding robot tasks.

Statement

A statement is the minimum unit that configures a program, and is configured of a command word and data issued to the word.

Example

```
MOV   P1
```

Command word Data Command statement

Appended statement

Command words can be connected with an appended statement, but this is limited to movement commands. This allows some commands to be executed in parallel with a movement command.
Example

```
MOV P1 WTH M_OUT (17) = 1
```

Command statement Appended statement Command statement instructions
(MOV, MVS, MVR, MVR2, MVR3, MVC, MVA)

Line

A line is consisted of a line No. and one command statement. Note that if an appended statement is used, there will be two command statements. One line can have up to 127 characters. (This does not include the last character of the line.)
Line No.

Line Nos. should be in ascending order, starting from the first line, in order for the program to run properly. When a program is stored in the memory, it is stored in the order of the line Nos.
Line Nos. can be any integer from 1 to 32767.

Label

A label is a user-defined name used as a marker for branching.
A label can be created by inserting an asterisk (*) followed by uppercase or lowercase alphanumeric characters after the line No. The head of the label must be an alphabetic character, and the entire label must be within eight characters long. If a label starting with the alphabetic character L is described after the asterisk, an underscore (_) can be used immediately after the character.
* Characters that cannot be used in labels:
•Reserved words (DLY, HOPEN, etc.)
•Any name that begins with a symbol or numeral
•Any name that is already used for a variable name or function name

Example

```
10 GOTO *LBL
100 *LBL
```

Robot operation control

Joint interpolation movement

The robot moves with joint axis unit interpolation to the designated position.
(The robot interpolates with a joint axis unit, so the end path is irrelevant.)

Command word Explanation

MOV - The robot moves to the designated position with joint interpolation.

Statement example Explanation

```
MOV P1          ' Moves to P1.
MOV P1+P2       ' Moves to the position obtained by adding the P1 and P2 coordinate
elements.
```

Table 5: Introduction to MELFA-BASIC

Command	Explanation	Example
MOV	Moves the robot to a teach-point position	MOV P1
MVS	Moves the robot to a teach-point in a straight line	MVS P1
	Moves the robot to a position above the teach-point in a straight line. (Z-Axis distance in Tool-frame)	MVS P1, -50
OVRD	Override speed limit (0 to 100%) (never use more than 30 for safety ! make this the first line of your program)	MVS 20
DLY	Delay in seconds – Robot waits	DLY 0.5
HOPEN	Opens the gripper	HOPEN 1
HCLOSE	Closes the gripper	HCLOSE 1
GOSUB	Calls a subroutine	GOSUB *PICK
RETURN	Returns from the subroutine	RETURN
DEF POS	Defines a position variable	DEF POS PTMP
END	End of program	END

5.2.5 *Joint Interpolation Movement*

The robot moves with joint axis unit interpolation to the designated position.
(The robot interpolates with a joint axis unit, so the end path is irrelevant)

i. *Command Word Explanation*
MOV- *The robot moves to the designated position with joint interpolation.*

ii. *Statement example explanation*
MOV P1 *'Moves to P1.*
MOV P1+P2 *'Moves to the position obtained by adding the P1 and P2 coordinated elements.*

iii. *example*

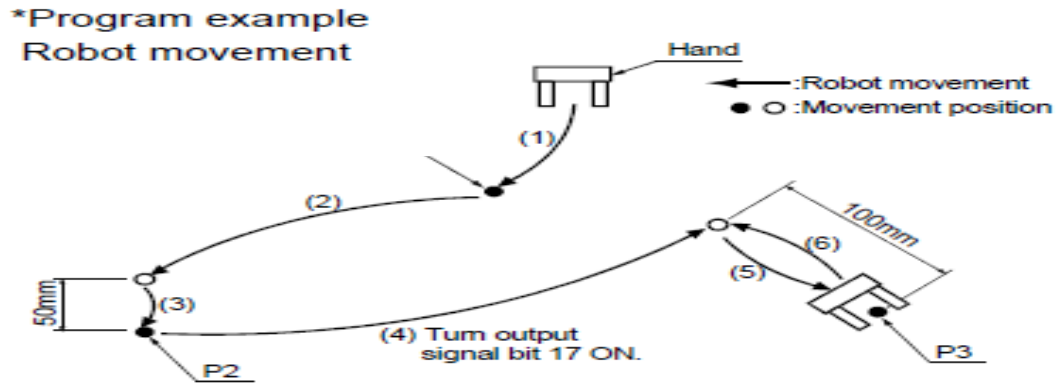


Figure 7: *Robot Movement*

iv. *Program and Explanation*

Table 6: Program and Explanation

	Program	***Explanation***
10	MOV P1	*Moves to P1*
20	MOV P2,-50	*Moves to P2 to a position rectacted 50mm in the hand direction*
30	MOV P2	*Moves to P2*
40	MOV P3,-100 WTH_OUT(17)=1	*Starts movement from P3 to a position retracted 100mm in the hand direction and turn ON output signal bit 17*
50	MOV P3	*Moves to P3*
60	MOV P3,-100	*Returns from P3 to a position retracted 100m in the hand direction*
70	END	*Ends the program*

5.2.6 Linear Interpolation Movement

The end of the hand is moved with linear interpolation to the designated position.

i. *Command word interpolation*

MVS – *The robot to the designated position with linear interpolation. It is possible to specify the interpolation form using the TYPE instruction.*

ii. Programmed example:

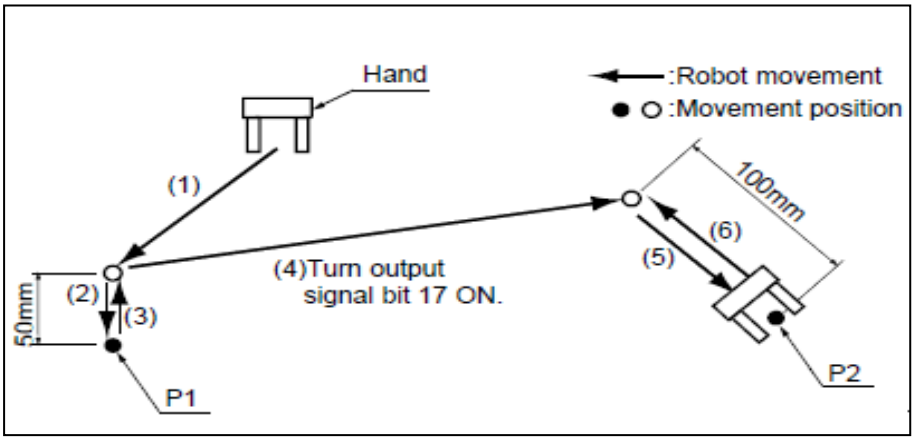


Figure 8 : *Robot Movement*

iii. *Program and Explanation*

Table 7: Program and Explanation

Program	***Explanation***
10 MVS P1,-50	*Moves with linear interpolation from P1 to a position retracted 50mm in the hand direction*
20 MVS P1	*Moves to P1 with linear interpolation*
30 MVS,-50	*Moves with linear interpolation from the current position(P1) to a position retracted 50mm in the hand direction*
40 MVS P2,-100 WTH M_OUT(17)=1	*Output signal bit 17 is turned on at the same time as the robot start moving*
50 MVS P2	*Moves with linear interpolation P2*
60 MVS,-100	*Moves with linear interpolation from the current position (P2) to a position retracted 50mm in the hand direction*
70 END	*Ends the program*

5.2.7 How To Move Mitsubishi RV-2AJ Robot?

To perform robot movements, two buttons should be pressed simultaneously, the button below the teaching box known as the dead man switch and the "STEP / MOVE" button. Sounds 'beep' from PWM servo can be heard and the display of "SVO ON" green LED lights up.

Robots can perform Joint-jog or Cartesian-jog (XYZ) movements, for the Cartesian movement, press the XYZ button. The X-labeled keys, + X, -Y, + Y, -Z, + Z can now be used to move the robot. The A-labeled keys, + A for rotation of the robot arm end of the Z axis are better known as gripper. The labeled keys, -B, + B to move the gripper up and down. To open and close the gripper, the "HAND" button is pressed simultaneously with "+ C" or "-C". HAND + + C to open the gripper and HAND + -C to cover the gripper.

Automatic Operation is used to move programs stored in the robot's main control unit. To select and activate robot movements, the selection of saved programs should be created. Press the "CHNGDISP" button until the status shows "P.xxxxxx". Press the "Up" or "Down" button to select the program. Activate the servo by pressing the "SVO ON" button. Press "START".

If the "END" button is pressed, the robot will complete the program cycle and stop. If the "STOP" button is pressed, the robot will stop immediately.

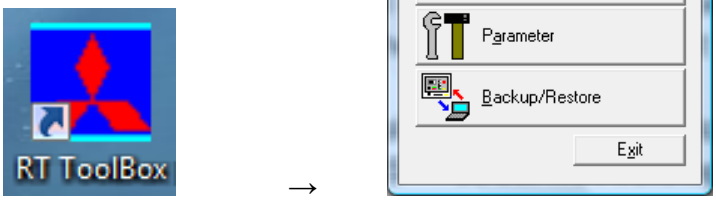
5.2.8 To On RV2AJ robot and Communicate with PC

Turn the MODE button on Controller at AUTO (Ext) mode.

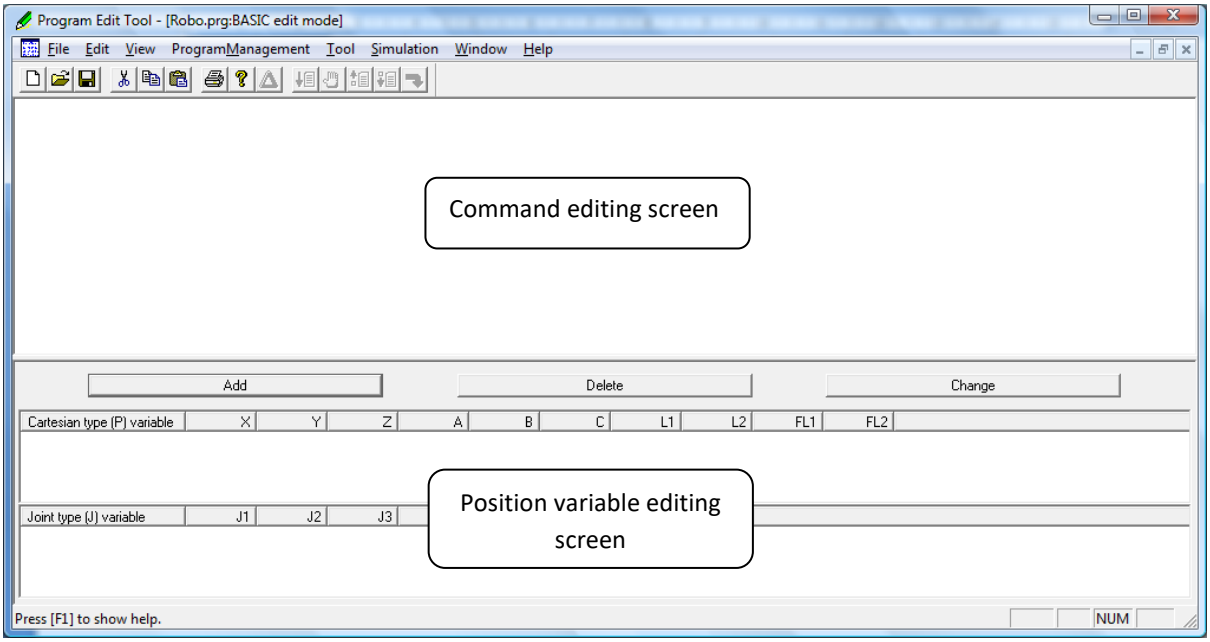
Turn the ENABLE/DISABLE switch on Teach Pendant at DISABLE mode.

Opening the RT ToolBox

Desktop → RT ToolBox → Program Edit

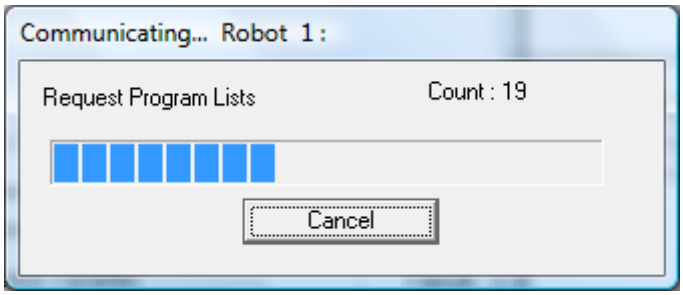


Screen Layout (tool boxes)



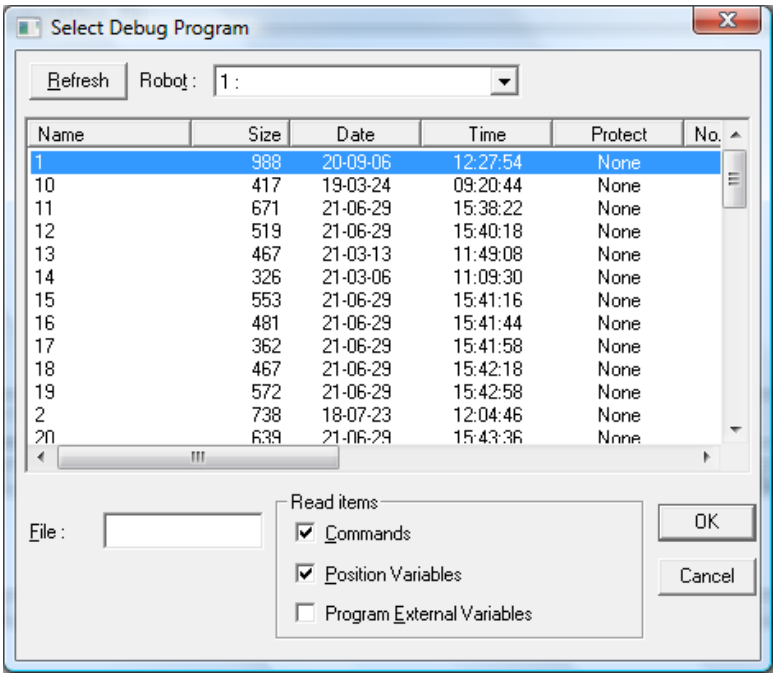
Communicate with robot online

Click on Debug [online]

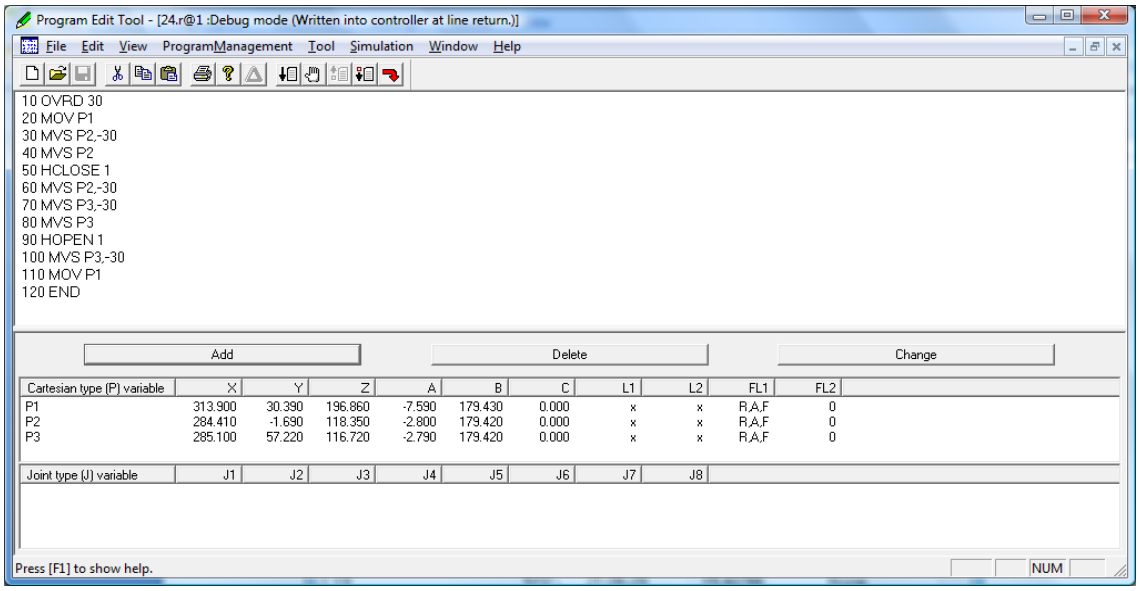


Opening a project file

Select the file needed.

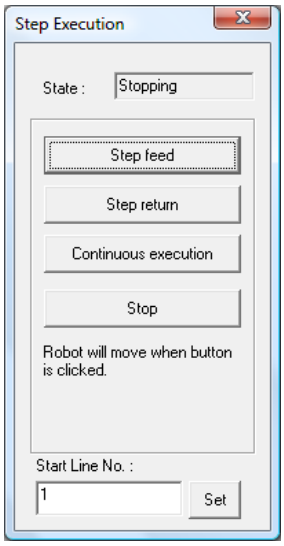


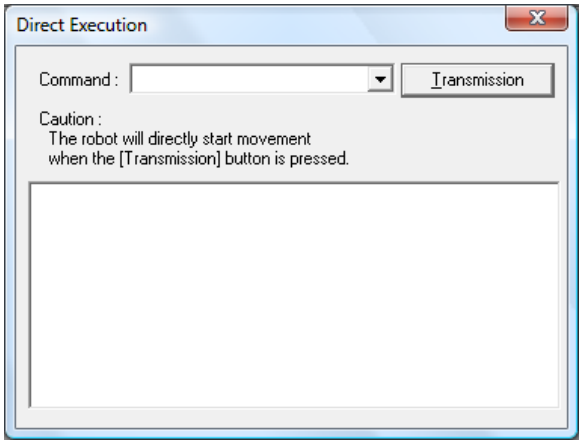
Code program will show as below.



Run the program.

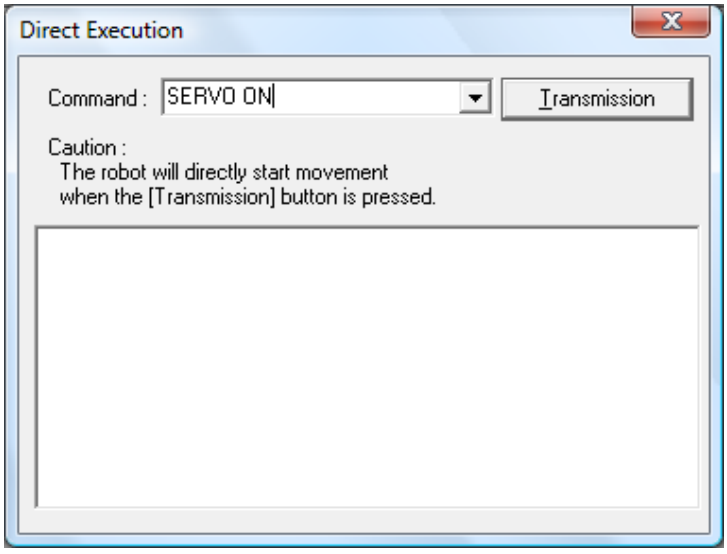
Step Execution → Direct Execution





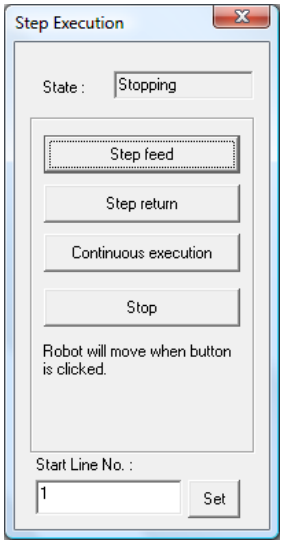
On the robot's servo

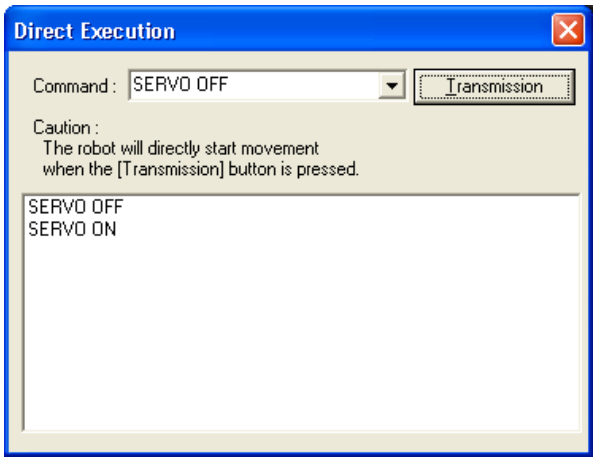
Direct Execution → Command → SERVO ON → Transmission



On the step execution

- Modified start line no. : then "set"
- Select "Step feed", "Step return" or "Continuous Execution" for execution.





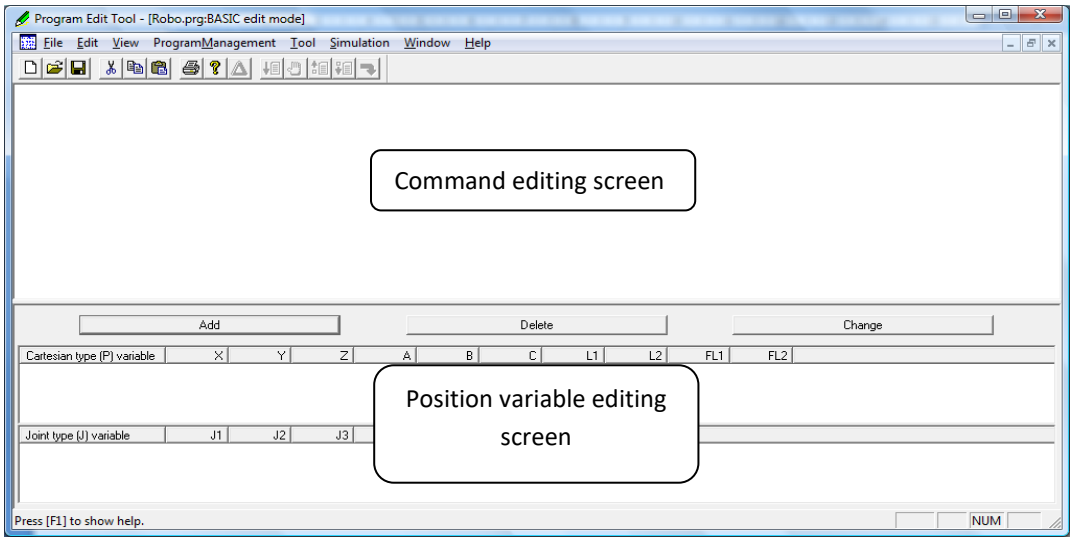
Off the robot's servo

Direct Execution → Command → SERVO OFF → Transmission

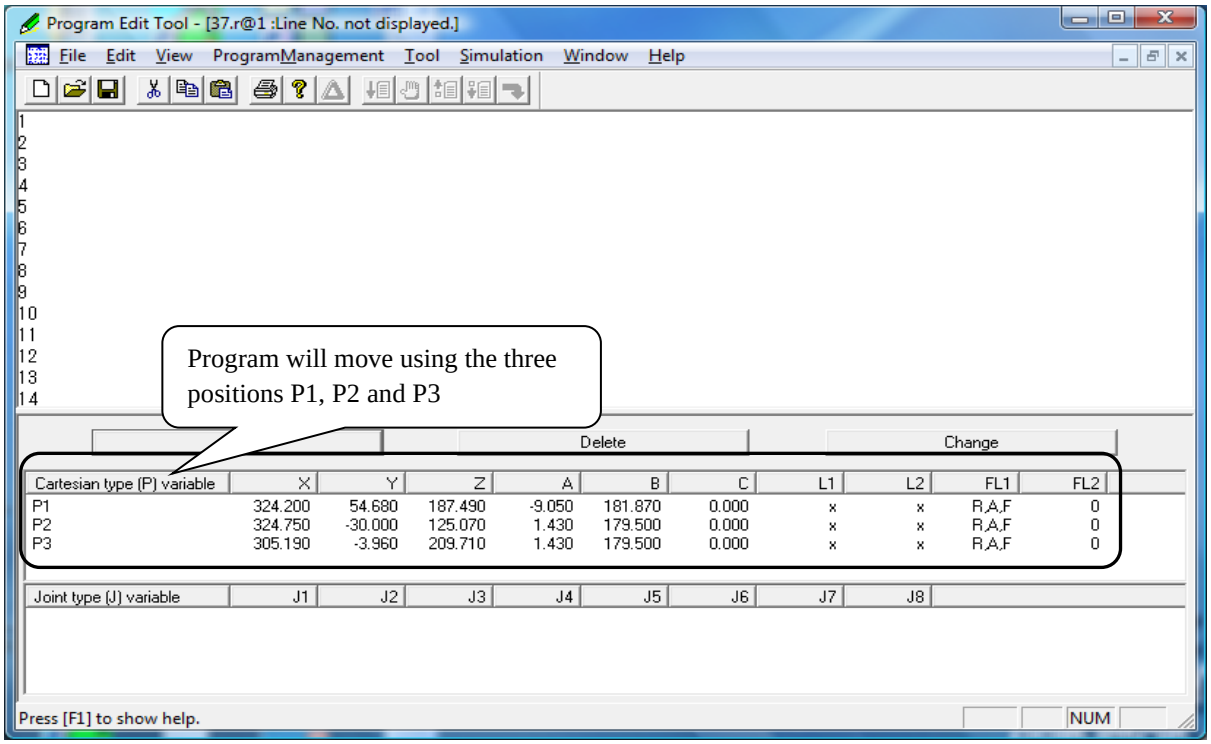
Create a new program file.

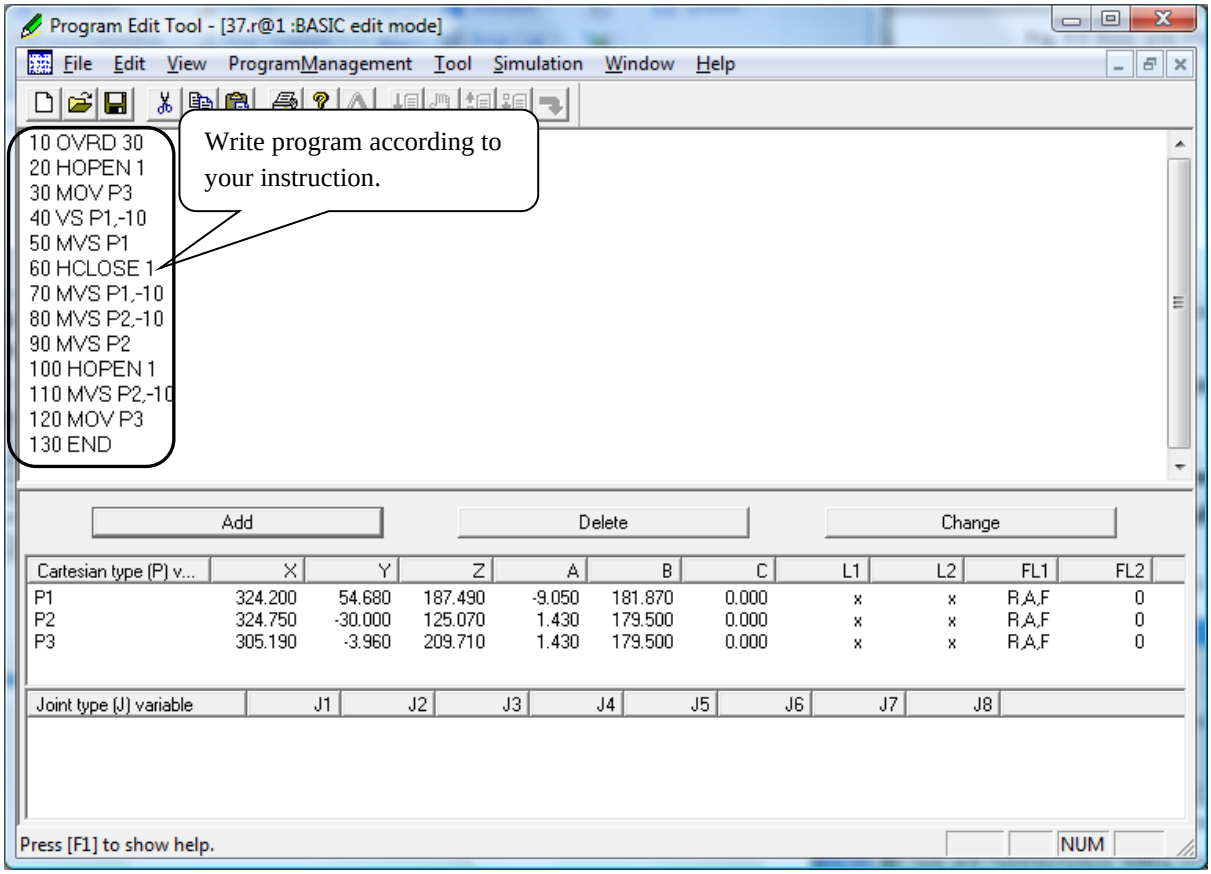
File → New or click on 

The following type of editing screen will appear.



File → Open Robot
Then select file needed.
Window → Line No. Hide Mode
Then copy all the code and delete them.





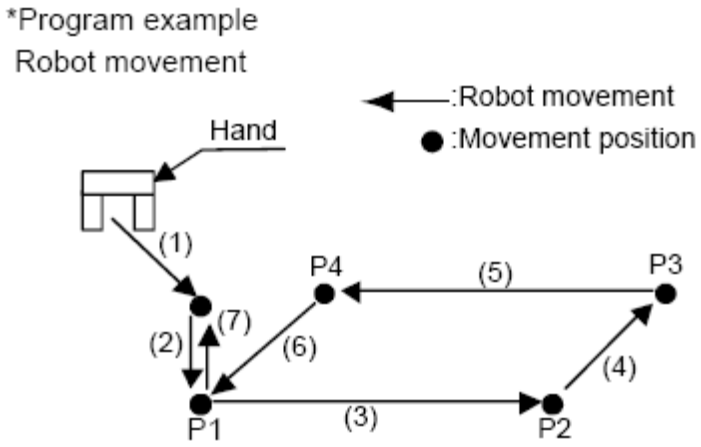
Save the program after done program the robot.

File → Save As -> Robot.

Or click on 

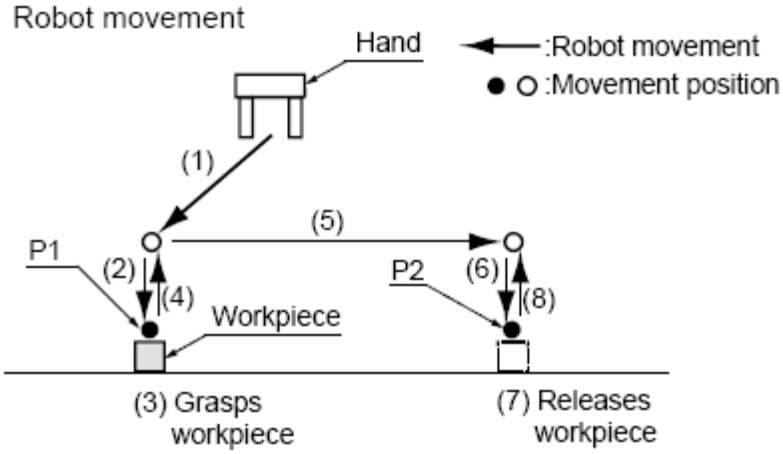
6.0 TASK/EXERCISE

EXERCISE 1



Write a program

Linear interpolation movement
The end of the hand is moved with linear interpolation to the designated position.
Command word Explanation
MVS - The robot moves to the designated position with linear interpolation. It is possible to specify the interpolation form using the TYPE instruction



Write a program

EXERCISE 2

You are required to create a program to move the robot processor by referring to Figure 1,

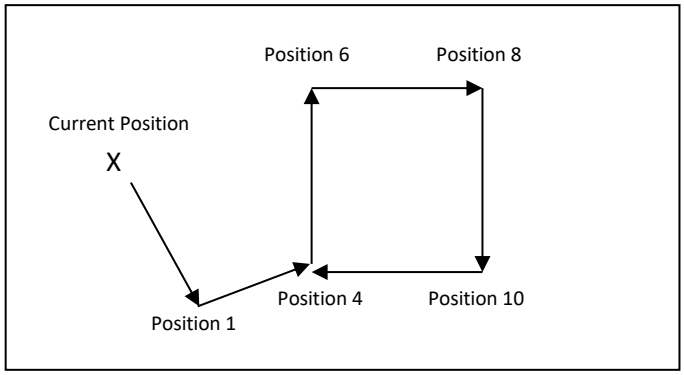


Figure 1

Steps:

i) Create a robot program using the Teach-Point Position (MOV) and Teach-Point in a Straight Line (MVS) methods as specified in the MELFA-BASIC Command.
ii) Key in the required data as shown in Diagram 1.
iii) Create a simple program such as the above example program based on the field description of the comment that has been given.

Command	Explanation
	Set speed to 20%
	Move to positions 1 by joint interpolation
	Move to positions 4 by linear interpolation
	Move to positions 6 by linear interpolation
	Move to positions 8 by linear interpolation
	Move to positions 10 by linear interpolation
	Move to positions 4 by linear interpolation

EXERCISE 3

i) With Sketching, tick Four (4) points in the box under figure 2 in accordance with Command and complete the comment field on each command

Command	Explanation
10 OVRD 15	
20 MOV P1	
30 MVS P3	
40 MVS P4	
50 MOV P2	

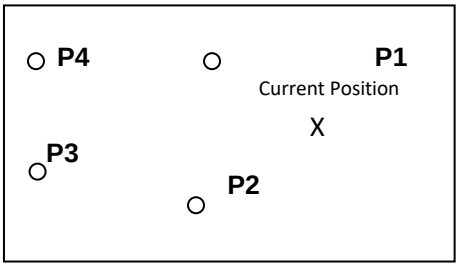


Figure 2

EXERCISE 4

You are required to create a program to move the robot hardware by referring to Figure 3

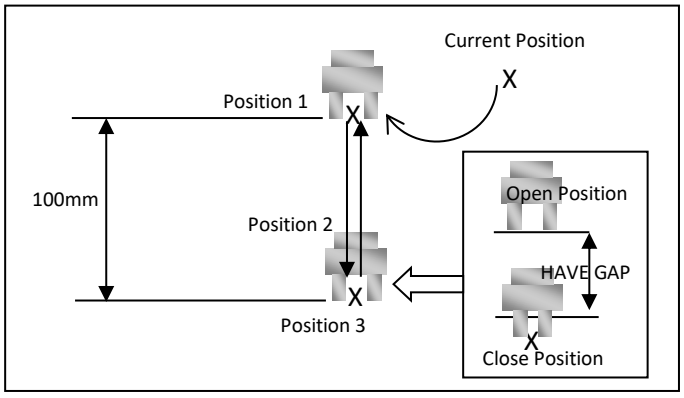


Figure 3

Steps:

i) Create a robot program with the Teach-Point Position (MOV), Teach-Point In a Straight Line (MVS) and Open / Close Gripper methods as specified in the MELFA-BASIC Command.
ii) Key in the required data as shown in Figure 3.
iii) Create a simple program above with comment field description.

Command	Explanation

7.0 RESULT/DATA

7.1 Answer exercise 1 – 4

8.0 DISCUSSION

Based on Result/Data and analyze your result.

9.0 CONCLUSION AND RECOMMENDATION

Your conclusion should be related to your practical and theoretical understanding on the related topic.

10.0 REFERENCES

CODE & COURSE NAME	**:**	**DJF41032 - MANUFACTURING WORKSHOP PRACTICE 3**
TITLE	**:**	**PLASTIC PROCESSING**
DURATION	**:**	**4 HOURS PER WEEK**

1.0 WORKSHOP OUTCOMES

At the end of this task, the student should be able to:

1.1 Solve the problem of the machine or plastic product according to proper procedures.
1.2 Adapt knowledge and skill to operate and troubleshoot the machine or equipment base on Standard Operational Procedure (SOP).
1.3 Identify the defect problems on plastic products correctly in group.

2.0 THEORY

Thermoforming is a manufacturing process where plastic sheet is heated to a pliable forming temperature, form to a specific shape in a mould, and trimmed to create a usable product. The sheet or 'film' and certain material types, is heated in an oven to a high enough temperature that it can be stretched into or onto a mould and cooled to a finished shape.

Free Forming This method of thermoforming does not use a mold. Instead, an acrylic sheet is clamped in a frame and either a vacuum or compressed air draws the material to a desired depth. An electric eye determines when the proper depth has been reached and cuts off the pressure. Since only air touches the sheet of material, there is no mark off. Free forming is used to create windshields for planes, skylights, or anything where optical quality is necessary.

Advantage is achieving high clarity.

Vacuum forming is a simplified version of thermoforming, whereby a sheet of plastic is heated to a forming temperature, stretched onto or into a single-surface mold, and held against the mold by applying vacuum between the mold surface and the sheet.

Normally, draft angles must be present in the design on the mold, otherwise release of the formed plastic and the mold is very difficult.

Vacuum forming is usually – but not always - restricted to forming plastic parts that are rather shallow in depth. Thin sheet is formed into rigid cavities for unit doses of pharmaceuticals and for loose objects that are carded or presented as point-of-purchase items. Thick sheet is formed into permanent objects such as turnpike signs and protective covers.

Relatively deep parts can be formed if the formable sheet is mechanically or pneumatically stretched prior to bringing it in contact with the mold surface and before vacuum is applied.

Pressure forming is a variation of vacuum forming that utilizes both vacuum and compressed air to force the plastic sheet against the mold. As the platens are closed, the vacuum pulls on one side of the sheet and compressed air pushes on the other. Specially shaped tooling is used to match the top and bottom halves of the mold creating a seal to

maintain pressures of up to 500 psi, therefore, the platens must be locked together. This compressed air pressure reduces the cycle time and makes it possible to run at lower temperatures, it also improves the distribution of the material creating a more even wall thickness and enhances the detail of the part to a nearly-injection-molded quality. After the part has been formed, the platens unlock and one of the platens moves out of the way to speed up the cooling process. The increased air pressure will require a stronger

3.0 APPARATUS/EQUIPMENTS

3.1 Thermoforming machine
3.2 Plastic sheets
3.3 Thermal glove
3.4 Mould

4.0 SAFETY PRECAUTIONS

4.1 Always keep the floor clean.
4.2 Always keep the floor clean.
4.3 Always use the correct tool for the job.
4.4 Keep tools in the boxes or racks when not in use.
4.5 Operate the machine with wearing personal protective equipment such as glove and mask.
4.6 Never try to bypass the guard safety interlock.
4.7 Make sure that all safety devices are working properly.

5.0 PROCEDURE

5.1 Preheat the oven to the desired temperature for the type of plastic you are forming.

5.2 Place the item you are using for forming on the forming area. Make sure it is positioned precisely as you want it to be shaped out of the plastic.

5.3 Place the plastic within the frames and use the binder clips to secure it.

5.4 Put on heat-resistant gloves and place the plastic in the oven. As the plastic is being heated, carefully observe it. The plastic will first tighten up and then begin to sag. The amount of sag you want will vary depending on the shape you want to create.

5.5 Turn on the vacuum.

5.6 Remove the plastic from the oven and place it on the forming machine. This should be done as fast as possible, so the plastic remains soft and impressionable.

5.7 Allow the vacuum suction to work the plastic for a few minutes and then turn off the vacuum.

5.8 Remove the plastic from the frames after it has had time to cool. You should now have a hardened and formed piece of plastic.

6.0 Result/Data

Observe the product that was produce and describe.

NO.	TEMPERATURE/TIMES	RESULT

7.0 Discussion

7.1 Analyse the quality of the product. (include the product sample).

7.2 Give your opinion why temperature and pressure are the most important variables in thermoforming process? Expain your answer.

8.0 Conclusion And Recommendation

Your conclusion should be related to your workshop objective and suggest your recommendation to improve the quality of product.

9.0 References

State your reference either refer to books, articles, or journals.

RUBRICS

1.PRACTICAL TASK (P)

2.PRACTICAL TASK (A)

3. MINI PROJECT (P)

4. MINI PROJECT (A)

5. WORKSHOP REPORT

POLITEKNIK MALAYSIA
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PRACTICAL TASK (P) (CLO1,PLO5,P3,CLS3a/3c)

CRITERIA		SCALING					MARKS
		VERY WEAK	WEAK	FAIR	GOOD	VERY GOOD	
		1	2	3	4	5	
A	FOLLOW INSTRUCTION	Rarely follows instructions	Sometimes follows instructions	Frequently follows instructions	Constantly follows instructions	Perfectly follows instructions given	[/5]
B	INTERPERSONAL SKILLS IN GROUP WORK	Does not interacts positively within a group, even with prompting and shows frequent lack of sensitivity to others feeling and abilities in opinions expressed	Rarely to interacts positively within a group, even with prompting and shows frequent lack of sensitivity to others feeling and abilities in opinions expressed	Interacts with other group members if prompted, but sometimes expresess opinions which are insensitive to the abilities and feelings of others	Interacts with all group members spontaneously and contributes in a way that is sensitive to the abilities and feelings of others	Interacts positively with all group members, encourage such interaction in others, and always sensitive to the abilities and feelings of others contributions.	[/5]
C	PARTICIPATION TO ACHIEVE GROUP GOALS	Shows little commitment to group goals and fail to perform assigned roles	Demonstrate commitment to group goals, but has difficulty performing assigned roles	Demonstrate moderate commitment to group goals,and has a little difficulty performing assigned roles	Demonstrates commitment to group goals and carries out assiged roles effectively	Actively helps to identify groups goals and works effectively to meet them in all roles assumed	[/5]
D	PROCEDURAL KNOWLEDGE	Selects appropriate or inappropriate skills and/or strategies required by the task and makes critical errors in applying them	Selects and applies appropriate skills and/or strategies required by the task, but makes a number of non critical errors in doing so	Selects and applies appropriate skills and/or strategies required by the task, but makes moderate number of non critical errors in doing so	Selects and applies the appropriate strategies and/or skills specific to the task without significant errors	Select and applies appropriate strategies and/or skills specific to the task without error, and applies some in innovative ways	[/5]
E	ANALYSIS	Not able to organise and analyse gathered information or data and fails to define the factors that contribute to the problem/issue or explain the root of the problem.	Finds difficulty in organizing and analysing gathered information or data and finds difficulty in explaining the factors that neither contribute to the problem/issue nor explains the root of the problem.	Able to organise and analyse gathered information or data, but does not clearly describe the factors that contribute to the problem/issue or clearly explain the root of the problem.	Able to organise and analyse gathered information or data, clearly describe the some factors that contribute to the problem/issue or explain the possible roots of the problem.	Able to organise and analyse gathered information or data, clearly describe the factors thatcontribute to the problem/issue or explain the root of the problem.	[/5]
F	SAFETY, HEALTH & ENVIRONMENT	Lack awareness of safety, health and conducive environmental practices. Does not able to follow instructions.	Rarely show awareness of safety, health and conducive environmental practices. Rarely able to follow instructions.	Sometimes show awareness of safety, health and conducive environmental practices. Sometimes to follow instructions.	Show good awareness of safety, health and conducive environmental practices. Able to follow instructions.	Show excellent awareness of safety, health and conducive environmental practices. Able to follow instructions strictly.	[/5]
G	USE OF EQUIPMENT	Uses tools, equipment and materials with limited competence	Uses tools, equipment and materials with some competence	Uses tools, equipment and materials with considerable competence	Uses tools, equipment and materials with competence	Uses tools, equipment and materials with high degree of competence	[/5]
H	WORK AREA	Requires constant reminders to clean work area	Requires reminders to clean work area	Cleans work area with only moderate reminders	Cleans work area with only minimal reminders	Routinely keep work area clean without reminders	[/5]
I	RETURN OF EQUIPMENT	Requires constant reminders to return equipment	Requires some reminders to return equipment	Return equipment with moderate reminder	Returns equipment with only minimal reminders	Always return equipment with no reminders	[/5]
J	TIME MANAGEMENT	No parts of the task are completed on time.	Some parts of the task are completed and turned in on time.	Half parts of the task are completed and turned in on time.	Most parts of the task are completed and turned in on time.	All parts of the task are completed and turned in on time.	[/5]
						TOTAL	**[/50]**

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PRACTICAL TASK (A) ETHICS & PROFESSIONALISM (CLO3,A3,PLO8,CLS5)								MARKS
CRITERIA			SCALING					
			VERY WEAK	WEAK	FAIR	GOOD	VERY GOOD	
			1	2	3	4	5	
A	ETHICS & PROFESSIONALISM	Work Responsibility	Does not perform assigned tasks within by the scope of work even with close supervision	Perform assigned tasks within by the scope of work with close supervision	Perform assigned tasks within by the scope of work and meets expectation	Perform assigned tasks within by the scope of work and exceeds expectation	Perform assigned tasks within by the scope of work and beyond expectation	[/5]
B		Work Relation	Has a disharmonious relationship with work groups	Has a less relationship with work groups	Has a satisfactory relationship with work groups	Has a good relationship with work groups	Has a well-acknowledged relationship with work groups	[/5]
C		Work ethics	Practice inappropriate working culture such as bad behaviour, no punctuality as well as not being efficient, productive and ethical at work in all situations	Practice less appropriate working culture such as inconsistent behaviour, less punctuality as well as being less efficient, productive and ethical at work in many situations	Practice good working culture such as good moral, timeliness as well as being efficient , productive and ethical at work in general	Practice good working culture such as good moral, timeliness as well as being efficient , productive and ethical at work in most situations	Always practice excellent working culture such as good moral, timeliness as well as being efficient , productive and ethical at work in all situations	[/5]
D		Quality of work	Provides work that reflects very little or no effort; shows negative behavior; is not honest	Provides less quality work that often reflects less effort; makes little effort to improve work; shows less positive behavior and is not often honest	Provides work that reflects a good effort and occasionally needs to be checked or redone; rarely shows negative behavior; is honest	Provides work of the best quality that reflects best effort; makes best effort to improve work; shows positive, proactive behavior; is always honest and encourages other to do the same	Provides work of the highest quality that reflects best effort; makes strong effort to improve work; shows positive, proactive behavior; is always honest and encourages other to do the same.	[/5]
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MINI PROJECT (P) (CLO2,PLO5,P4,CLS3a/3c)

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MINI PROJECT (A) ETHICS & PROFESSIONALISM (CLO3,PLO8,CLS5)

CRITERIA			SCALING					MARKS
			VERY WEAK	WEAK	FAIR	GOOD	VERY GOOD	
			1	2	3	4	5	
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REFERENCES

James L. Fuller (1990). Robotics, Introduction, Programming, and Projects. Prentice Hall

Jay Heizer & Barry Render, (2006). Production and Operation Management, 8th edition, Prentice

Hall Omron (1999). A Beginners Guide to PLC Omron Asia Pasific Pte

Kalpakjian, S., Schmid, S. R., &Kok, C. (2010). Manufacturing Processes For Engineering Materials. Singapore: Pearson-Prentice Hall.

Chua, C. K., Leong, K. F., & Lim, C. S. (2007). Rapid prototyping: Principles and Applications. New Jersey: World Scientific.

Quigley, M., Gerkey, B., & Smart, W. D. (2015). Programming Robots with ROS: A Practical Introduction to The Robot Operating System. Beijing: OReilly.

Petruzella, F. D. (2017). Programmable Logic Controllers. New York, NY: McGraw-Hill Companies.

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