



Test Project

National Level Skill Competitions

Skill-Mobile Robotics

House Cleaning Robot

**Swachh Ghar Swachh Shahar – A step towards clean
India**

Category: Manufacturing & Engineering Technology

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Section - A

A. Preface

Skill Explained:

Mobile Robotics is a fast evolving, solutions orientated, industry within which the robotics/technologist is a significant and growing work role. Mobile robotics is an important part of the future, with applications in everyday life, diverse industries, including manufacturing, agriculture, aerospace, mining, and medicine. A robotics technologist works in offices, manufacturing plants or laboratories; he or she designs, maintains, develops new applications and conducts research to expand the potential for robots. The role begins with a strong focus on a specific business problem, in a particular sector. For example, in manufacturing there may be a need to increase capacity by creating robots for tasks that can be automated. Mobile robots may also be designed to explore areas that are inaccessible or dangerous for human beings. Careful, deep client consultation is required, resulting in an accurate specification. The design phase follows and a prototype is assembled. The robot is then programmed and tested to ensure high, consistent performance. At the heart of every robot is a robotics technologist who thinks about what a robot needs to do and works with several disciplines to design and put together the optimal piece of equipment, demonstrating a commitment to attention to detail. In this instance the robotics technologist uses existing technologies to create solutions to new challenges. Robotics technologists must be familiar with logic, microprocessors, computer programming, mechanical, electrical, and control system so that they can design and prototype the right robot for each application. They must also prepare specifications for the robot's capabilities as they relate to the everyday life. In addition, robotics technologists are responsible for cost efficient design, cost-price calculations and quality-control. Integral to the role of the high performing robotics technologist are a range of skills related to work organization and self-management. Excellent communication and interpersonal skills, with a particular strength in working well in a team, are equally important. An ability to be innovative and creative in resolving technological challenges and generating solutions is also essential. Working across sectors internationally and being able to transfer analytical skills is a feature of the excellent robotics technologist, together with

a commitment to continuing specialist, and professional development and a determination to resolve problems through experimenting and risk taking within self-managed boundaries. In an increasingly global industry, which is 'breaking new ground' and altering the way we live and work, there are significant opportunities for sustainable careers in robotics. The opportunities carry with them the need to work with diverse cultures, industries and fast paced technological change. The diversity of skills associated with robotics technologists is likely to expand.

Eligibility Criteria (for IndiaSkills 2018 and WorldSkills 2019):

Competitors born on or after 01 Jan 1997 are eligible to attend the Competition. (i.e. The Competitors must not be older than 22 years in the year of the Competition.)

Mobile Robotics is a team skill competition with two Competitors per team.

Total Duration: 20 Hours

Section - B

B. Test Project

Prerequisites:

Competitors are required to design, fabricate and assemble a robot on the guidelines of the declared test project. The Sample Test Project is subjected to minimum 30% change. However, changes shall not require any change in the infrastructure requirements. The competitors shall be required to submit a soft copy of the technical documentation of the fabricated robot. The documentation shall include the Frame / Structural Elements Organization, the Wiring System Organization, the Mobility Management System Organization, the Object Management System Organization, the Computer Programming Organization.

Robot structure shall be fabricated by the competitors prior to the competition; no readymade structural components shall be used by the competitors. However, Robot shall be dismantled and reassembled at the competition venue.

Theme (House Cleaning Robot):

A family has just completed the supper. The robot is expected to segregate the dry and the wet waste from the dining tables (700 X 700 X Max. 450 mm). The dry waste is represented by red colour cylindrical object and the wet waste is represented by the green colour cylindrical object (Max. 60 mm Diameter and Max. 80 mm height).

The robot is further required to pick up the bins meant for the dry waste and the wet waste (Red and green circular plastic disc respectively – (Max. 12mm thick and Max. 150 mm diameter)) kept on the dining table and place them at the kitchen table sinks (700 X 700 X Max. 450 mm) area located in the balcony of the house.

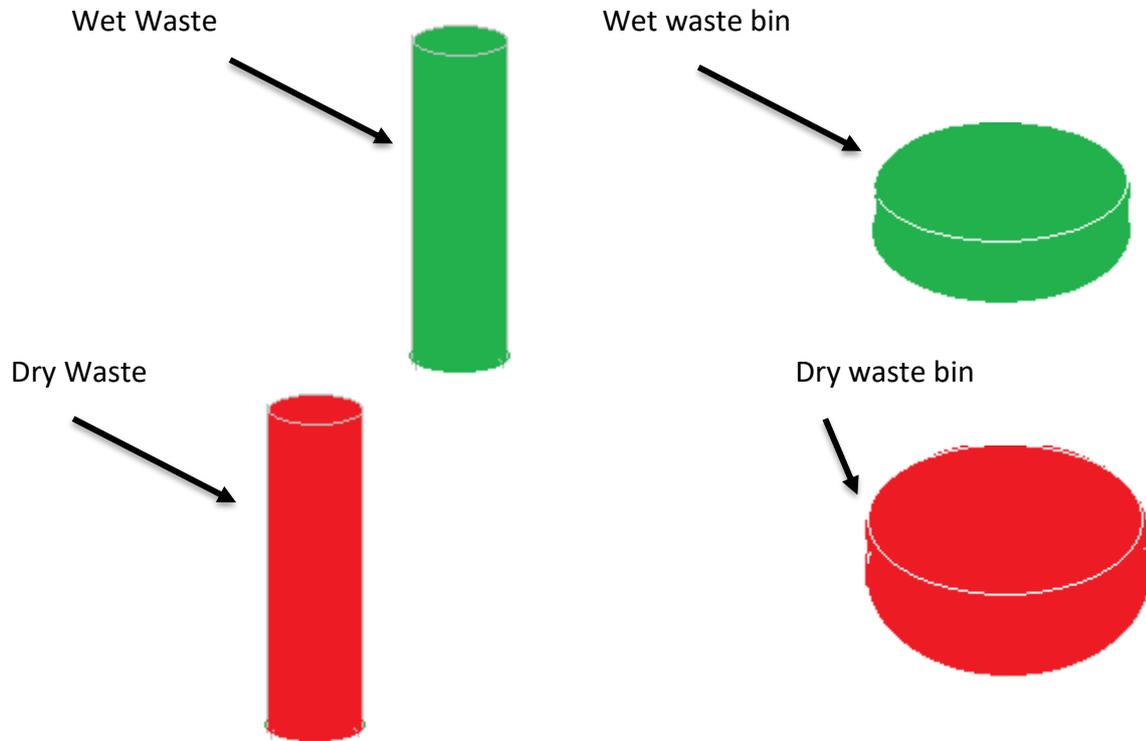
The Competitor built Robots task is to travel from the dining table, pick up the designated wet, dry waste bin and place it on the corresponding designated area of kitchen sink table (one at a time). Then the robot shall pick up the wet and dry waste and place on the bins already placed on the kitchen sink table.

The competitors also have to design the mobile robot in such a way that it is capable of performing the task in tele-operation, semi-autonomous mode and autonomous mode. The Teams shall get maximum 10 minutes to complete the task. The Object Management System and the Robot in combination can be in possession of a **Maximum of ONE Object** at a time.

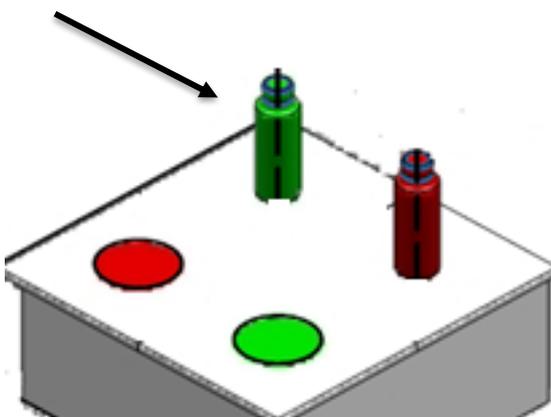
- It is mandatory for the competitors to use LabVIEW IDE and myRIO controller for the programming and implementation.

- However, competitors are free to use any other components to design, fabricate and assemble the robot.
- The robot should be equipped with a **camera** to transmit the video signal **wirelessly**.

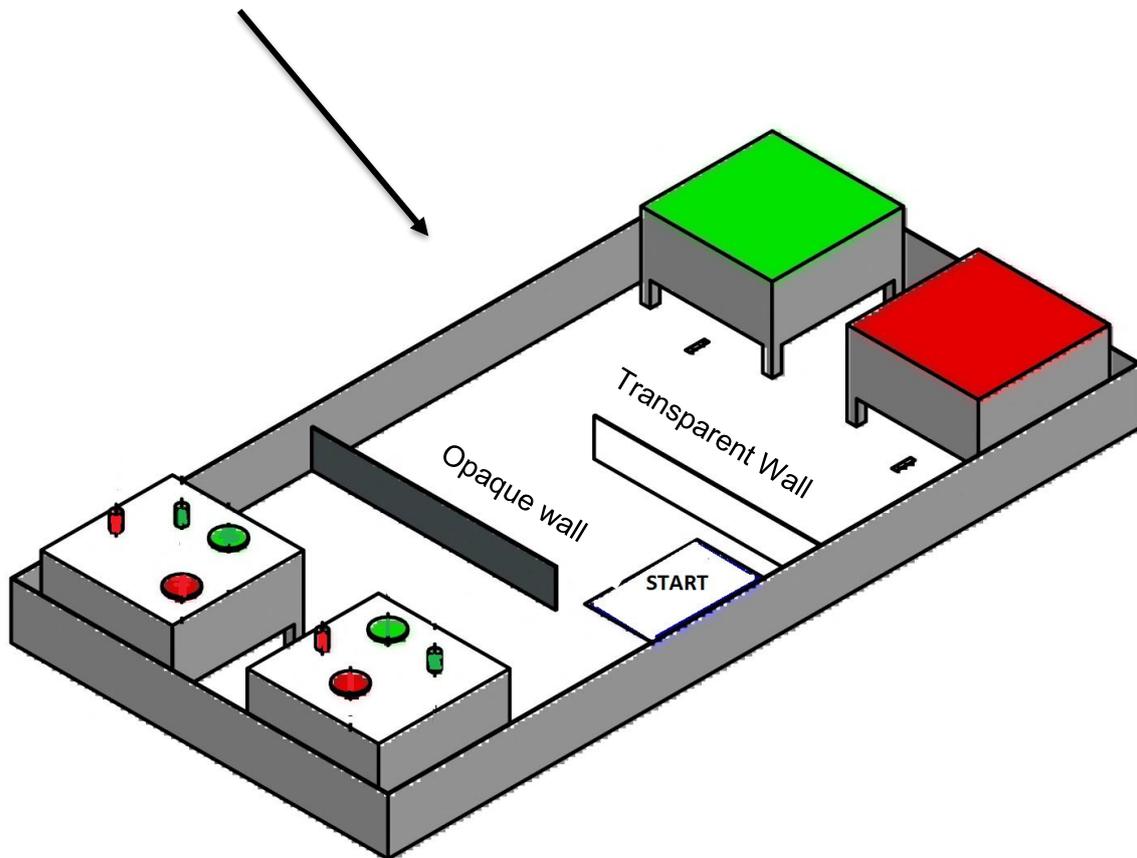
Example of typical dining table, wet and dry waste on the dining table and a kitchen sink table kept in the balcony.



Dining Table with Dry, wet waste and bin.



Typical layout of the game field.



The Playground's isometric view

Note: All the shaded walls of the game field (fencing) are white.

- The game field shall be a court of area 4m X 2m (detailed dimensions of the game field are given on the last page of the test project.)
- A Row of two dining tables of size (700 X 700 X Max. 450 mm).
- Wet waste and a wet bin Kitchen sink green or white table top (700 X 700 X Max. 450 mm). To be decided as a 30 % change.
- Dry waste and a wet bin Kitchen sink red or white table top (700 X 700 X 450 mm).
- A black strip of 24 mm width and 100 mm length may be provided in front of all the tables along the centre line. (May be decided to delete as a 30 % change to avoid hard coding before the start of the competition)
- A unique grid pattern of size 100 mm X 100 mm shall be provided on front side of all the tables with centre of the grid pattern and centre of the front coinciding.
- The Archway walls shall be Min. 1300 mm X Min. 200mm X 6mm transparent plastic / acrylic sheet on one side and a Min. 1300 mm X Min. 200mm X 6mm wood on the other side.

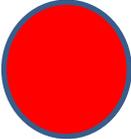
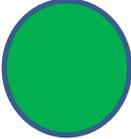
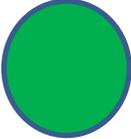
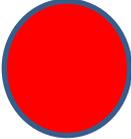
- The Designated Robot Starting Position is Inside a 600 by 600 mm Tape Line Square. (may be relocated to any place on the game field as a part of 30% change before the start of the competition)
- The Competitor Built Robots Task is to travel from the start position to kitchen dining table pickup waste and bin one at a time and delivered (to be placed inside the hollow booth area) to each of the kitchen sink table in the balcony of the house.
- **Module 1:- Tele-operation Mode – No direct line of sight**
 - The expert will fix 8 objects at random positions on the dining table. These positions will remain same for all the competitors for a given session.
 - The sequence of the position will be decided on the role of dice for each team before the performance test run.
 - The robot should be placed at start position.
 - During the performance test, the competitor shall sit at workstation near the arena facing the arena.
 - Competitors will operate their robot manually **through wireless remote / laptop or desktop computer.**
 - Eight objects kept on the dining tables shall be delivered to the kitchen sink tables in the balcony at the appropriate designated location.
 - The teams will get maximum 10 minutes to deliver all 8 Objects.
- **Module 2:- Semi autonomous mode**
 - The expert will fix 8 objects at random positions on the dining table. These positions will remain same for all the competitors for a given session.
 - The sequence of the position will be decided on the role of dice.
 - The robot should be placed at start position.
 - Competitors will operate their robot manually through wireless remote/laptop. The competitors shall sit with their back facing the arena. They shall view the Image on the laptop monitor vide the camera mounted on the robot
 - Eight objects kept on the dining tables shall be delivered to the kitchen sink tables in the balcony at the appropriate designated location.
 - The teams will get maximum 10 minutes to deliver all 8 Objects.

Module 3:- Autonomous mode

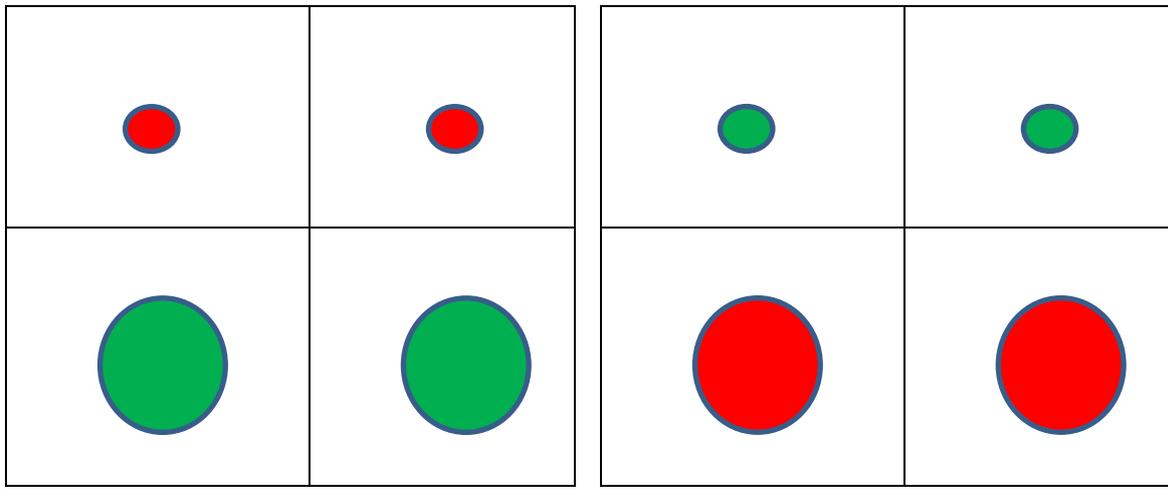
- The expert will fix 8 objects at random positions on the dining table. These positions will remain same for all the competitors for a given session.

- The sequence of the position will be decided on the role of dice.
- The robot should be placed at start position (The final location of the robot shall be decided as a 30 % change and can be located any feasible point on game field).
- Competitors will operate their robot by press of a button (No restart shall be allowed).
- The robot shall operate autonomously after the single button is pressed.
- After successfully picking one bin or waste from the dining table and placing object on the appropriate location on the kitchen sink table in the balcony.
- The competitors can manually keep the robot at the start position for picking next object (This can also be changed as a part of 30% change to make the complete game autonomous).
- Eight objects kept on the dining tables shall be delivered to the kitchen sink tables in the balcony at the appropriate designated location.
- The teams will get maximum 10 minutes to deliver 4 Objects (Two pair of waste and corresponding bin)
- **Deciding the sequence of position of Objects (Example):-**
 - A location of the dry waste, wet waste and dry bin and dry waste can be decided by the throw of the dice. Th details of the location are as given below.

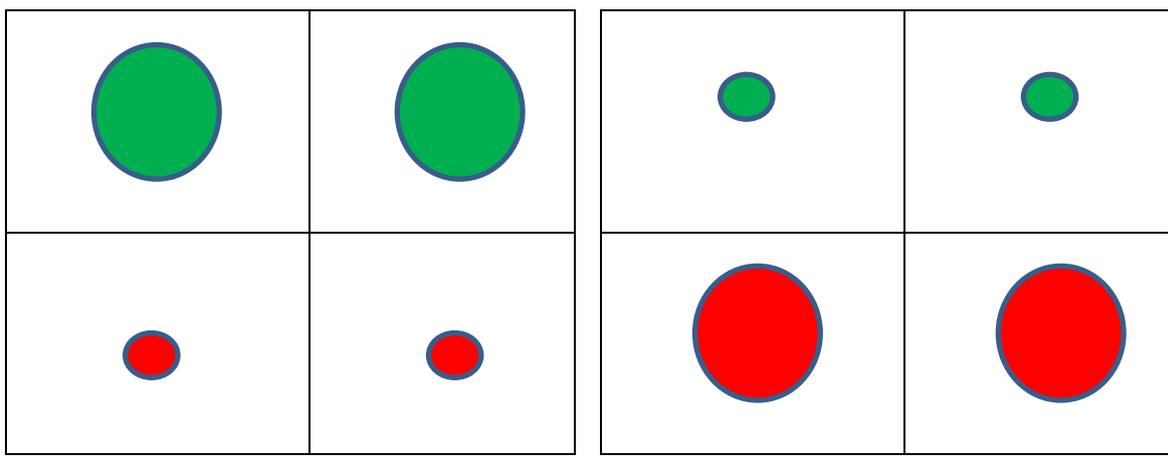
Dice Value 1

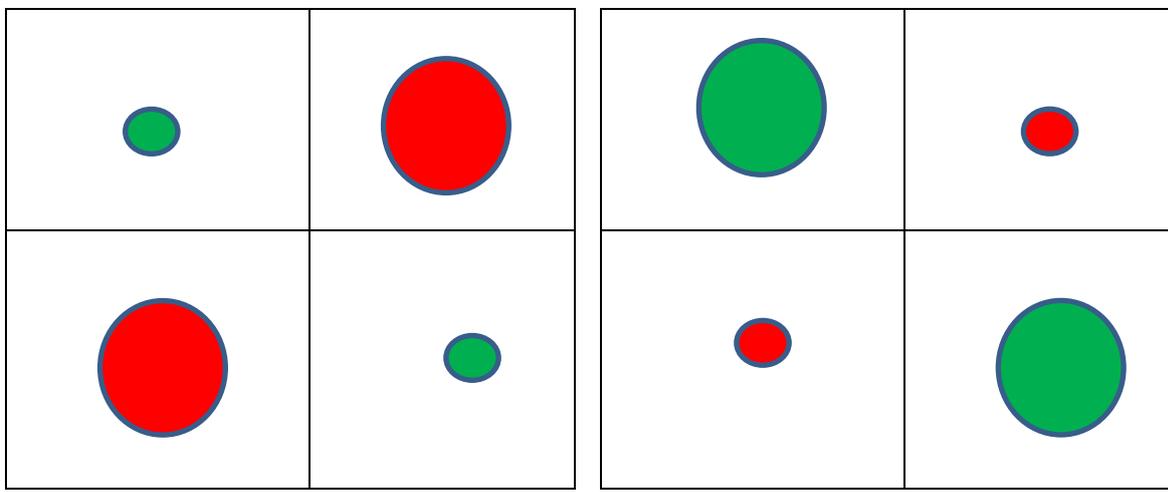
Dice Value 2



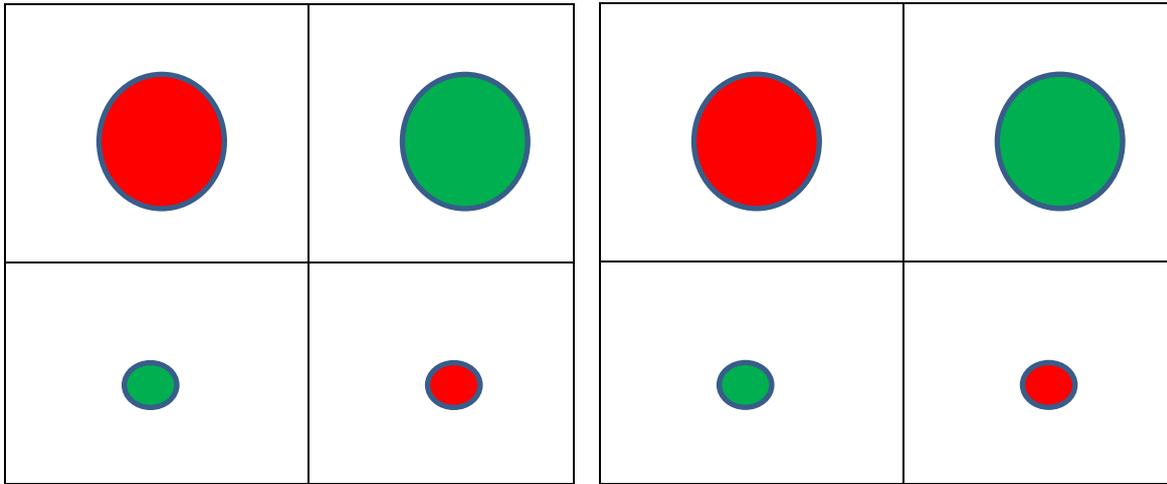
Dice Value 3



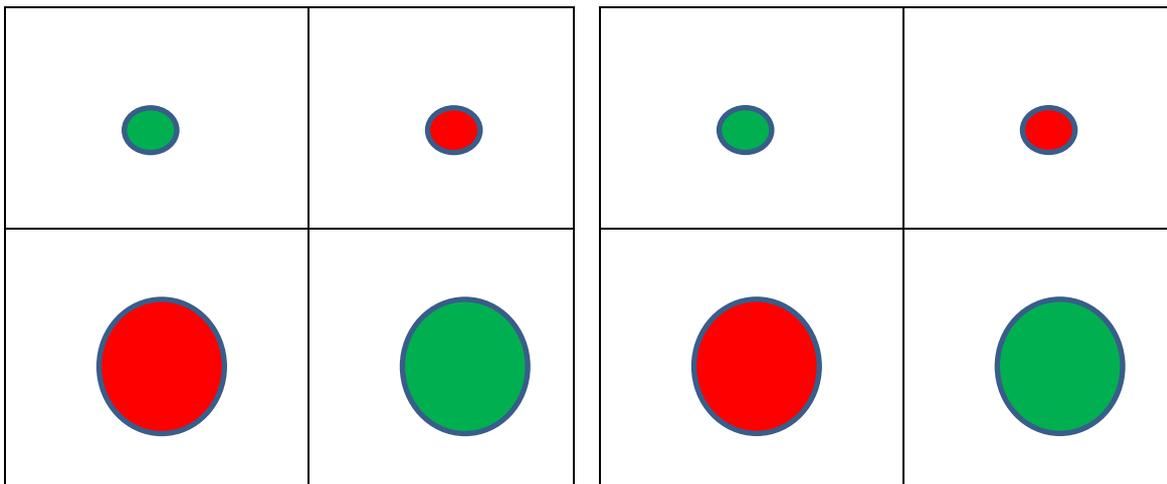
• **Dice Value :4**



- **Dice Value 5:**



- **Dice Value 6**



Section –C

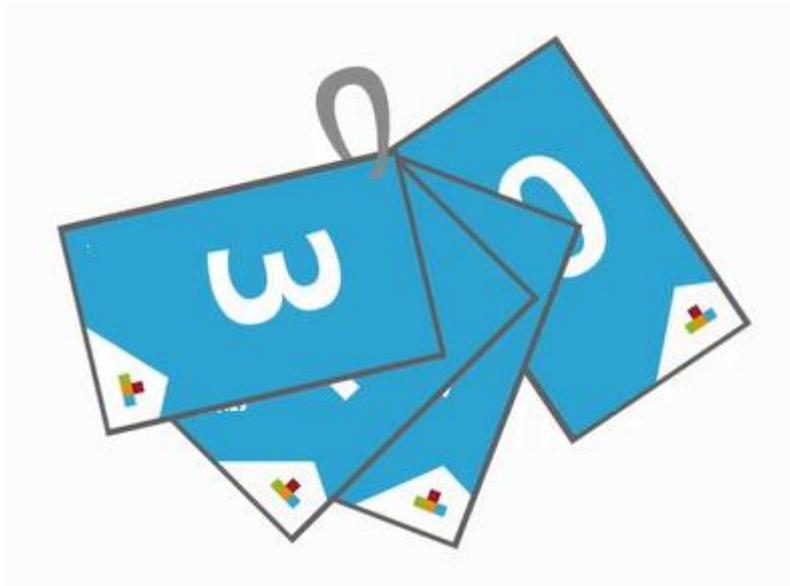
C. Marking Scheme

The Assessment is done by awarding points by adopting two methods, Measurement and Judgments

- Measurement(M) –One which is measurable
- Judgments(J)-Based on Industry expectations

Method:

Flash cards are used for judgmental as shown in figure below.



- Three experts will do the judgment.
- Experts select a score between 0 and 3.
 - 0: performance below industry standard
 - 1: performance meets industry standard
 - 2: performance meets and, in specific respects, exceeds industry standard
 - 3: performance wholly exceeds industry standard and is judged as excellent
- Experts display their scores at the same time and these scores are recorded.
- The set scores awarded must not differ by more than 1.
- If the scores differ by more than one, discussion is allowed, with reference to the detailed descriptor for each score, in order to bring the scores into the permitted range.

Example-Judgment Marking

If maximum marks for Judgment criteria is 1 and if all 3 Experts (Juries) give 3 points to a candidate, the candidate will get 1 mark for that aspect. If 2 Experts give 3 and 1 Expert gives 2 points, then candidate will get $(3+3+2)/9*1 = 0.89$ marks for that aspect out of 1 mark.

The tasks for performance with allocation of marks are as follows;

- Criteria A - Work organization & Management - 10 Marks
- Criteria B - Communication & Interpersonal Skills – 10 Marks
- Criteria C – Design – 15 Marks
 - Base Unit Core mobility performance
 - Simple Object Handling Task
 - Fabrication and Assembly
- Criteria D - Prototyping – 10 Marks
- Criteria E - Programming, Testing & Adjustment – 15 marks
- Criteria F – Performance Review and Commissioning – 40 marks

The Detailed Marking Form is attached as Annexure

Criteria A:

The individual needs to know and understand:

- Principles and applications of safe working generally and in relation to manufacturing
- The purposes, uses, care and maintenance of all equipment and materials, together with their safety implications
- Environmental and safety principles and their application to good housekeeping in the work environment
- Principles of team working and their applications
- Personal skills, strengths and needs relative the roles, responsibilities and duties of others individually and collectively
- The parameters within which activities need to be scheduled

The individual shall be able to:

- Prepare and maintain a safe, tidy and efficient work area
- Prepare self for the tasks in hand, including full regard to health and safety
- Schedule work to maximize efficiency and minimize disruption

- Take account of the rules and regulations in force for robotics technician/engineering
- Select and use all equipment and materials safely and in compliance with manufacturers' instructions
- Apply or exceed the health and safety standards applying to the environment, equipment and materials
- Restore the work area to an appropriate state and condition
- Contribute to team performance both broadly and specifically
- Give and take feedback and support

Criteria B:

The individual needs to know and understand:

- The range and purposes of documentation and publications in both paper based and electronic forms
- The technical language associated with the skill and technology
- The standards required for routine and exception reporting in oral, written and electronic form
- The required standards for communicating with clients, team members and others
- The purposes and techniques for maintaining and presenting records, including financial records

The individual shall be able to:

- Read, interpret and extract technical data and instructions from documentation in any available format
- Use research for problem solving and continuing professional development
- Communicate by oral, written and electronic means to ensure clarity, effectiveness and efficiency
- Use a standard range of communication technologies
- Discuss complex technical principles and applications with others
- Explain complex technical principles and applications to non-Experts
- Complete reports and respond to issues and questions arising
- Respond to clients' needs face to face and indirectly
- Arrange to gather information and prepare documentation as required by the client
- Complete reports and respond to issues and questions arising

Criteria C: Design

The individual needs to know and understand:

- The principles and applications of project design
- The nature and formats of project specifications
- The bases on which the manufactured item will be appraised
- Design parameters can include the following:
 - Options appraisal
 - Selection of components, materials and work processes
 - Prototype development
 - Manufacture
 - Assembly
 - Refinement
 - Commissioning
- Principles and applications for:
 - Designing, assembling and commissioning mobile robotics systems
 - The components and functions of electrical and electronic systems
 - The components and applications of add-ons
 - The components and applications of mobile robotics systems
- Principles and applications of design and assembly of mechanical, electrical and electronic systems, their standards and their documentation
- Principles and methods for work organization, control and management in relation to the product

The individual shall be able to:

- Analyse the briefs or specifications to identify the required performance characteristics of the mobile robot
- Identify and resolve areas of uncertainty within the briefs or specifications
- Identify the characteristics of the environment in which the mobile robot is required to operate
- Identify hardware requirements to support the mobile robots' performance
- Generate designs for the manufacture of a functioning item within given timescales
- Generate designs for a tele-operation control system independent of the base unit
- Develop strategies to solve mobile robotics tasks including navigation and orientation

- Generate innovative solutions to design challenges
- Identify and appraise options for selection, purchase and manufacture of materials, components and equipment
- Record decisions on the basis of business principles and other essential factors such as health and safety
- Prepare documentation for work management and control
- Complete the design stage within given limits of purpose, cost and time

Criteria D: Prototyping

The individual needs to know and understand:

- Basic principles of mechanical, electrical and electronics technician/engineering
- Principles of fabrication and assembly
- Principles and practices of safe manufacture and operation

The individual shall be able to:

- Fabricate frame parts of the mobile robot
- Integrate the structural and mechanical parts of the mobile robot
- Integrate the electronic control circuits
- Install, set up and make all necessary physical and software related adjustments required for effective use
- Install, set up and make all necessary adjustments to the mechanical, electrical and sensor systems
- Install, set up and make all necessary adjustments required for effective tele-operation of the mobile robot
- Integrate sensors to gain control of the required tasks

Criteria E: Programming, testing and adjustment

The individual needs to know and understand:

- Manufacturers' control software
- How to program using standard industrial software
- How a software program relates to the action of machinery and systems
- Principles and applications of wireless communications
- Robot navigation by orientation and mapping
- Sensor integration
- Analytical techniques for fault finding
- Techniques and options for making adjustments and repairs
- Strategies for problem solving
- Principles and techniques for generating creative and innovative solutions

The individual shall be able to:

- Visualize the process and operation using software
- Use the manufacturer provided control software to assert effective autonomous control over the manufacturer provided object management systems
- Use industrial standard programming software to assert effective autonomous control over the robot's movement
- Use tele-operation to assert effective control over systems
- Implement programming methodologies to the control systems
- Assert robot movement by implementing orientation and mapping capabilities
- Implement a navigation strategy
- Install and make physical settings adjustments to sensors
- Install cameras on the robot and make appropriate adjustments
- Test run individual applications and full functionality
- Find and document faults using appropriate analytical techniques
- Demonstrate basic IT knowledge
- Repair or change components efficiently

Criteria F: Performance Review and Commissioning

The individual needs to know and understand:

- Criteria and methods for testing equipment and systems
- Criteria and methods for operating test runs
- The scope and limits of the technologies and methods used
- Strategies for thinking creatively and generating innovation
- The possibilities and options for making incremental and/or radical changes

The individual shall be able to:

- Test each part of the mobile robot against agreed operating criteria
- Test the mobile robot's overall performance against agreed operating criteria
- Optimize the operation of each part of the system, and the system as a whole, through analysis, problem solving and refinement
- Undertake a final test run to commission the system
- Review each part of the process of design, fabrication and assembly, and operation, against established criteria, including accuracy, consistency, time and cost
- Ensure that all aspects of the design stage meet the required industry standards
- Finalize and present a portfolio to the client, the portfolio to include all essential documentation required in a business transaction
- Present the mobile robot and portfolio to the client and respond to questions

Section - D

D. Infrastructure List

The Organizers are responsible to arrange for the Play Field of with a non glossy Particle Board.

The Items required for the Competitions are as follows;

- Particle board of 4m by 2m with a non glossy white paint or a PVC sheet coating on one side.
- Black Electrical insulation tape.
- Grid pattern printed on white paper of size 100 mm X 100 mm.
- It is mandatory to use LabVIEW and myRIO
- No restriction for use any sponsored / make of components for other components.
- Transparent plastic sheet 1300 mm X 200 mm X 6 mm.
- Opaque white (white nonglossy paint or PVC sheet) wood particle board of size Min. 1300 mm X Min. 200 mm X 6 mm.
- Four wooden tables of size 700 X 700 X Max. 450 mm.
- Two green cylindrical objects of any size of Max. 60 mm diameter with a height of Max. 80mm.to represent wet waste.
- Two red cylindrical objects of any size of Max. 60 mm diameter with a height of Max. 80 mm.to represent dry waste.
- Two green circular disc objects of any size of Max.150 mm diameter with a height of 12mm.to represent wet waste bin.
- Two red circular disc objects of any size of Max. 150 mm diameter with a height of 12mm.to represent dry waste bin.
- Grid pattern for Kitchen sink table of size 100 mm X 100 mm.

Section –E

E. Instructions for candidates

- All experts shall ensure that the robots have been dismantled to the component level of their original packing before the start of the competition.
- Safety of the robot and competitors is very important. Hence all the competitors shall provide a easily accessible emergency switch button to stop the robot instantly in case of uncontrollable operations.
- Competitors shall provide inbuilt safety fuse.
- The competitors shall provide a functional green light Indication, whenever the robot is in motion and a red light, whenever the robot is powered on but not in motion.
- Experts shall not be allowed to give any help to Competitors to interpret the Test Project except where agreed by the Jury before the start of the competition
- Competitors have the right to expect fairness, honesty, and transparency during the Competition
- Every Competitor has the right to expect that no other Competitor will receive unfair assistance or any intervention that may provide an advantage
- Interference by officials or spectators that may hinder or assist Competitors in the completion of their Test Project is forbidden
- Accredited personnel at the Competition shall ensure that the above principles of honesty, fairness and transparency are always observed
- When the Competition is over, Competitors shall be given time to exchange views and experiences with other Competitors and Experts.
- In case a Competitor has to withdraw due to illness or accident; marks will be awarded for the work completed.
- In the event of Competitor fall ill or has an accident, it must be informed to Expert (Jury member)
- No expert shall evaluate his own team (If applicable)

Note: Any query or problem shall be highlighted timely and before the start of the competition or when the incidence occurs so as to timely validate the observation and initiate appropriate actions timely.

Section -F

F. Health, Safety, and Environment

Following are the suggested personal protective equipment's during the competition.

- Safety footwear - Mandatory and all time
- Protective gloves - While doing drilling operation
(If Required)
- Protective glasses / face protection - While doing drilling operation
(If required)

1. All accredited participants and supporting volunteers will abide by rules and regulations with regards to Health, Safety, and Environment of the Competition venue.
2. All participants will assume liability for all risks of injury and damage to property, loss of property, which might be associated with or result from participation in the event. The organizers will not be liable for any damage; however, in case of Injury the competitor will immediately inform the immediate organizer for medical attention.

Mark Summary Form for Level - I Competition

Skill: 23 – Mobile Robotics

Name of Competitors: 1. _____ 2. _____

Aspect ID	Description	Max. Marks	Marks Obtained
A	Work Organization & Management - Marking shall be Judgemental	10	
A1	Co-operative Behaviour with Compatriot Team Member (Shall be monitored during all the time of competition vide one audit in each of the session and continuous monitoring by all experts) – Total 5 sessions (One mark for each session)	5	
A2	Team Space Condition (Shall be monitored during all the time of competition vide one audit in each of the session and continuous monitoring by all experts) – Total 5 sessions (One mark for each session)	5	
B	Communication and Interpersonal skills - Marking shall be Judgemental	10	
B1	Review of the Engineering Journal Frame / Structural Section	2	
B2	Review of the Engineering Journal Wiring Section	2	
B3	Review of the Engineering Journal Mobility Management Section	2	
B4	Review of the Engineering Journal Object Management Section	2	
B5	Review of the Engineering Journal Computer Programming Section	2	
C	Design	15	
C 1.1	A Flat Opaque Plate is brought in front of the Sensor Field and the Robot must AUTONOMOUSLY make a predetermined response such as Blink a LED	1.00	
C 1.2	A Flat transparent Plate is brought in front of the Sensor Field and the Robot must AUTONOMOUSLY make a predetermined response such as Blink a LED	1.00	
C 2.1	The Robot must complete a 1 M Forwards movement in the Open Playground Smooth Floor Space at one button press.	1.00	
C 2.2	The Robot must complete a 1 M Backwards movement in the Open Playground Smooth Floor Space at one button press	1.00	
C 2.3	The Robot must complete a Full 360-degree rotation while remaining in a Tape Line defined Square at one button press.	1.00	
C 2.4	The Robot is placed in a position of the Team's choosing relative to a Designated Object on the game field. The robot has to pickup the waste object and hold it without touching the ground.	2.00	

Aspect ID	Description	Max. Marks	Marks Obtained
C 2.5	The Robot is placed in a position of the Team's choosing relative to a Designated Object on the game field. The robot has to pickup the waste bin object and hold it without touching the ground.	2.00	
C 2.6	A Unique Grid pattern sheet of size 100 mm X 100 mm is brought in front of the robot, Robot must AUTONOMOUSLY make a predetermined response such as Blink a LED and should not respond if any other pattern is brought in front of robot. (i.e Robot should be able to identify the grid pattern)	2.00	
C 2.7	A unique colour (Red or Green) is brought in front of the robot, Robot must AUTONOMOUSLY make a predetermined response such as Blink a LED and should not respond if any other pattern is brought in front of robot. (i.e Robot should be able to identify the colour of the object)	2.00	
C 2.8	A black horizontal strip of size 24mm X 100 mm is placed in front of the robot at 90 degree at some distance. The robot should be able to identify the line and align itself along the axis of the black strip autonomously.	2.00	

Aspect ID	Description	Max. Marks	Marks Obtained
D	Prototyping	10.00	
D 1	Wiring installation meets Industry Standards for secure / safe installation Examination of the Robot's Wiring (secure wire placement, efficient wire organization, quality of connections, protection from Abrasion, inclusion of appropriate fusing and master safety switch)	4.00	
D 2	Frame Assembly meets Industry Standards for fit and alignment of components Examination of the Robot Frame's Structural Integrity (fit between connected components, accuracy of component alignment angles, sizes etc.)	2.00	
D 3	Object Management System meets Industry Standards for fit and alignment of components Examination of the Object Management System's Structural Integrity (fit between connected components, accuracy of component alignment angles, sizes etc.)	4.00	
E	Programming, Testing & Adjustment (No Direct line of Sight)	15.00	
E 1.1	The Robot's operational Safety Light Performance	1.00	
E 2.1	Robot exits out of the start position and travels the length of the dining table to the kitchen sink table through the tunnel way.	2.00	
E 2.2	Robot successfully picks up the first waste bin (No part of bin touching the dining table)	0.25	
E 2.3	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.1	Robot successfully delivers the first waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	
E 3.2	Robot successfully picks up the first waste (No part of bin touching the dining table)	0.25	
E 3.3	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.4	Robot successfully delivers the first waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
E 3.5	Robot successfully picks up the second waste bin (No part of bin touching the dining table)	0.25	

Aspect ID	Description	Max. Marks	Marks Obtained
E 3.6	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.7	Robot successfully delivers the second waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	
E 3.8	Robot successfully picks up the second waste (No part of bin touching the dining table)	0.25	
E 3.9	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.10	Robot successfully delivers the second waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
E 3.11	Robot successfully picks up the third waste bin (No part of bin touching the dining table)	0.25	
E 3.12	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.13	Robot successfully delivers the third waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	
E 3.14	Robot successfully picks up the third waste (No part of bin touching the dining table)	0.25	
E 3.15	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.16	Robot successfully delivers the third waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
E 3.17	Robot successfully picks up the fourth waste bin (No part of bin touching the dining table)	0.25	
E 3.18	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.19	Robot successfully delivers the fourth waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	

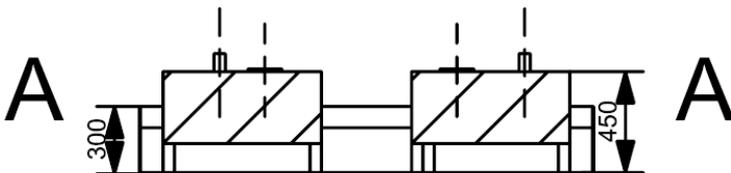
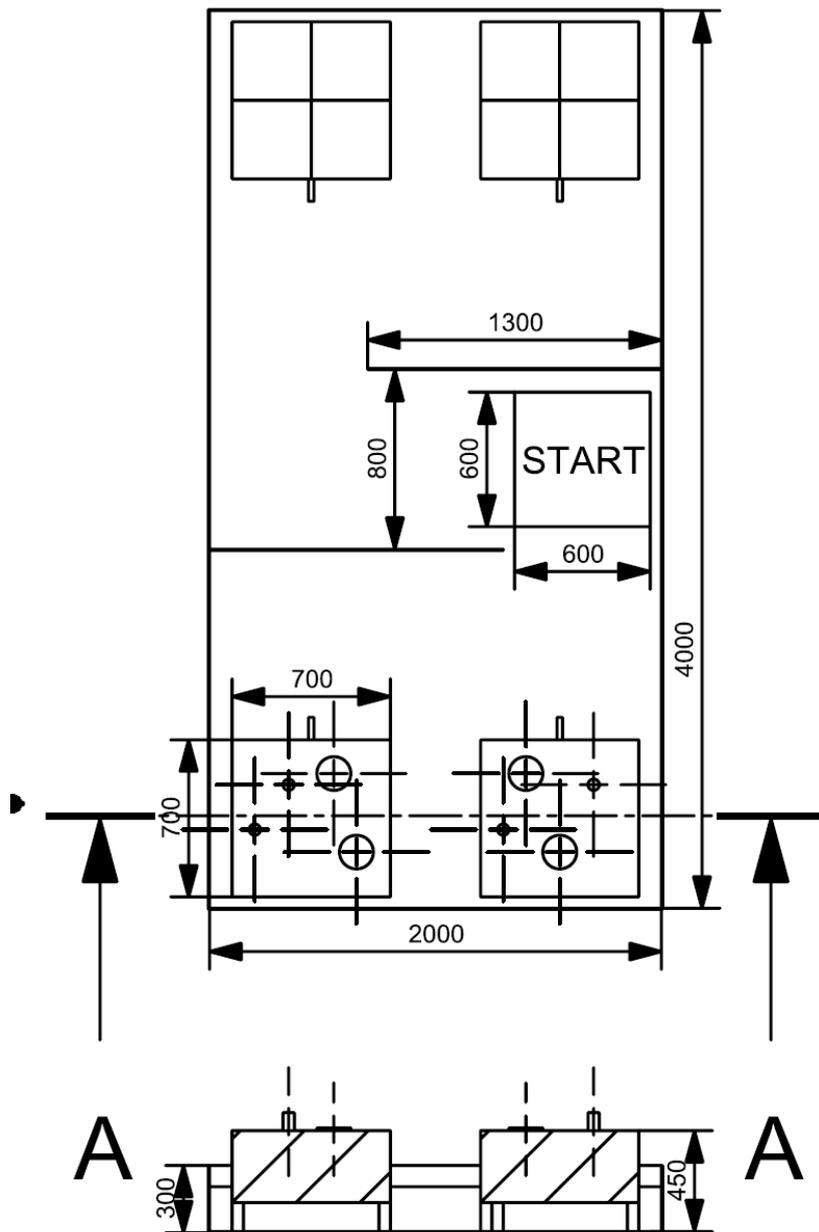
Aspect ID	Description	Max. Marks	Marks Obtained
E 3.20	Robot successfully picks up the fourth waste (No part of bin touching the dining table)	0.25	
E 3.21	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
E 3.22	Robot successfully delivers the fourth waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
F	Core Programming, Testing & Adjustment	40.00	
	No Line of Site (15)		
F1.1	The Robot's operational Safety Light Performance	1.00	
F 2.1	Robot exits out of the start position and travels the length of the dining table to the kitchen sink table through the tunnel way.	2.00	
F2.2	Robot successfully picks up the first waste bin (No part of bin touching the dining table)	0.25	
F2.3	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F3.1	Robot successfully delivers the first waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	
F3.2	Robot successfully picks up the first waste (No part of bin touching the dining table)	0.25	
F3.3	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F3.4	Robot successfully delivers the first waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
F3.5	Robot successfully picks up the second waste bin (No part of bin touching the dining table)	0.25	
F3.6	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F3.7	Robot successfully delivers the second waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	

Aspect ID	Description	Max. Marks	Marks Obtained
F3.8	Robot successfully picks up the second waste (No part of bin touching the dining table)	0.25	
F3.9	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F 3.10	Robot successfully delivers the second waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
F 3.11	Robot successfully picks up the third waste bin (No part of bin touching the dining table)	0.25	
F 3.12	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F 3.13	Robot successfully delivers the third waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	
F 3.14	Robot successfully picks up the third waste (No part of bin touching the dining table)	0.25	
F 3.15	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F 3.16	Robot successfully delivers the third waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
F 3.17	Robot successfully picks up the fourth waste bin (No part of bin touching the dining table)	0.25	
F 3.18	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	
F 3.19	Robot successfully delivers the fourth waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	1.00	
F 3.20	Robot successfully picks up the fourth waste (No part of bin touching the dining table)	0.25	
F 3.21	Robot successfully positions itself in front of Designated kitchen sink table Grid Pattern	0.25	

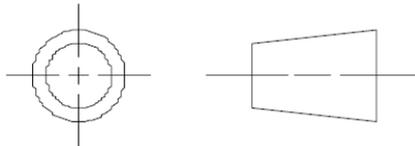
Aspect ID	Description	Max. Marks	Marks Obtained
F 3.22	Robot successfully delivers the fourth waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table) Note: Placing the waste on the corresponding waste bin is 1 Mark. Placing the waste on the appropriate table is 0.5 Mark	1.00	
Autonomous mode (25)			
F 3.23	The Robot's operational Safety Light Performance	1	
F 3.24	Robot exits out of the start position and position itself in front of the dining table.	1	
F 3.25	Robot successfully picks up the first pre-determined waste bin (No part of bin touching the dining table)	1	
F 3.26	The robot travels through the tunnel	1	
F 3.27	The robot positions itself in front of the kitchen sink table,	1	
F 3.28	Robot successfully delivers the first waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	2	
F 3.29	Robot successfully picks up the first pre-determined waste (No part of bin touching the dining table)	2	
F 3.30	The robot travels through the tunnel	1	
F 3.31	The robot positions itself in front of the kitchen sink table,	1	
F 3.32	Robot successfully delivers the first waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	2	
	Note: If the waste is placed on the correct waste bin 2.00 Marks to be awarded.		
	If the waste is not placed on the bin, then 1.00 Marks to be awarded.		
F 3.33	Robot successfully picks up the second pre-determined waste bin (No part of bin touching the dining table)	2	
F 3.34	The robot travels through the tunnel	1	
F 3.35	The robot positions itself in front of the kitchen sink table,	1	
F 3.36	Robot successfully delivers the second waste bin to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	2	

Aspect ID	Description	Max. Marks	Marks Obtained
F 3.37	Robot successfully picks up the second pre-determined waste (No part of bin touching the dining table)	2	
F 3.38	The robot travels through the tunnel	1	
F 3.39	The robot positions itself in front of the kitchen sink table,	1	
F 3.40	Robot successfully delivers the second waste to the correct location of the kitchen sink table (No part of robot is touching the waste bin or the kitchen sink table)	2	
	Note: If the waste is placed on the correct waste bin 2.00 Marks to be awarded.		
	If the waste is not placed on the bin, then 1.00 Marks to be awarded.		

Dimensions of the game Field:

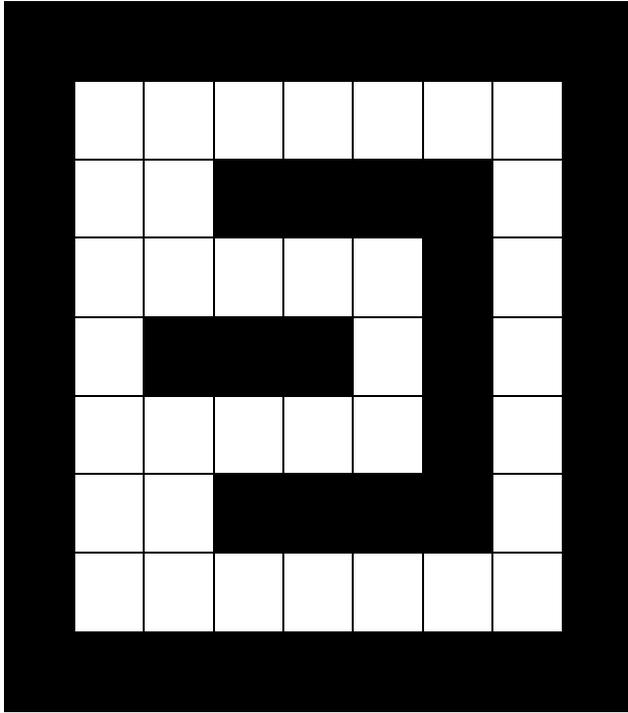


SECTION A-A

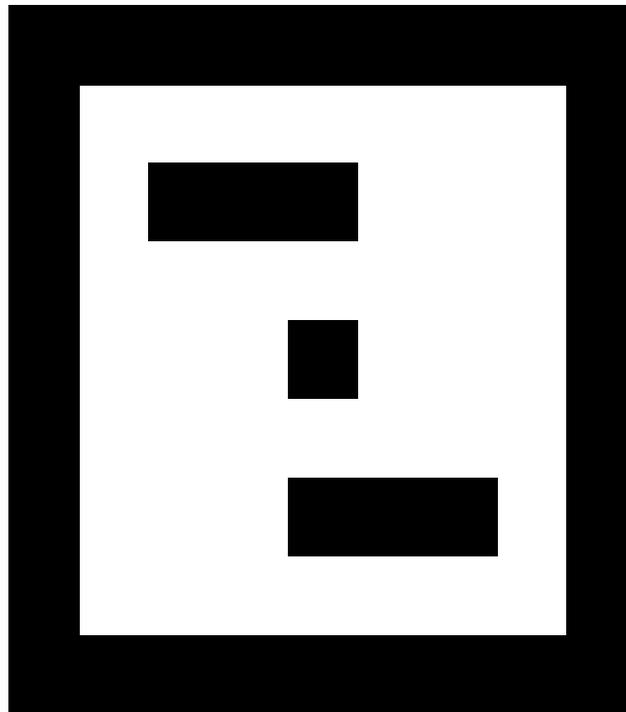


ALL DIMENSIONS IN MM

Annexure – Sample Grid Patterns

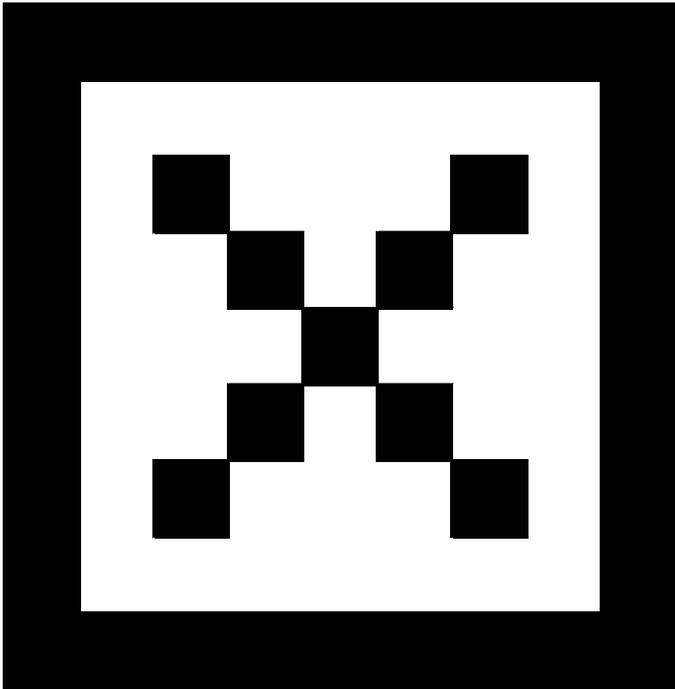


The grid lines are hidden, but shown for understanding of the pattern

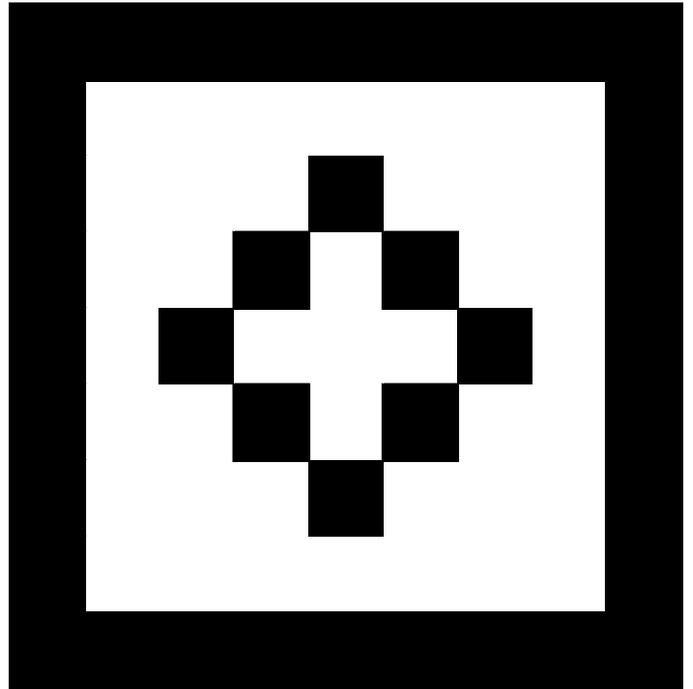


Note: You can generate your own grid pattern using the excel sheet document attached.

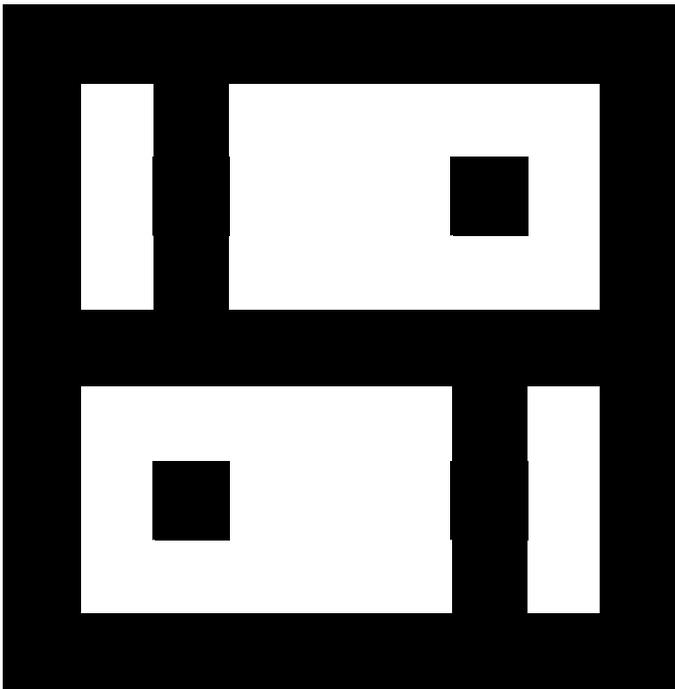
Grid Pattern Collection



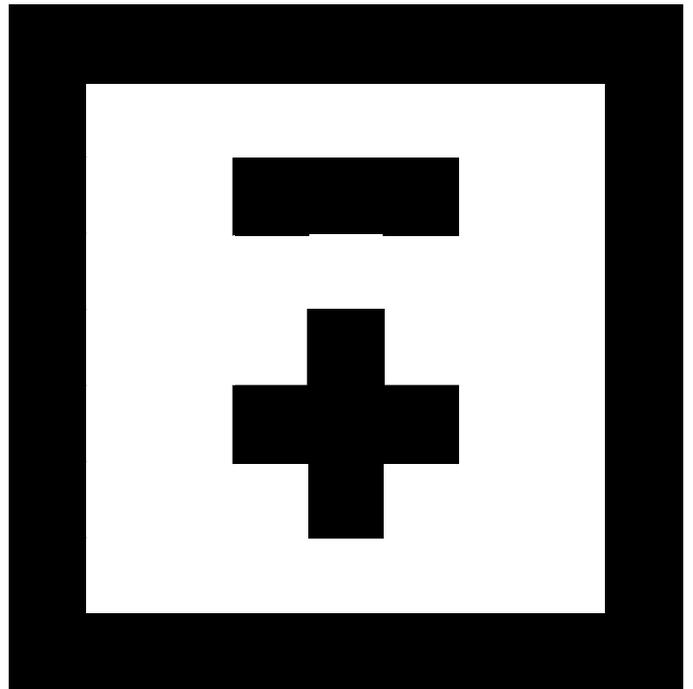
Grid Pattern 1



Grid Pattern 2

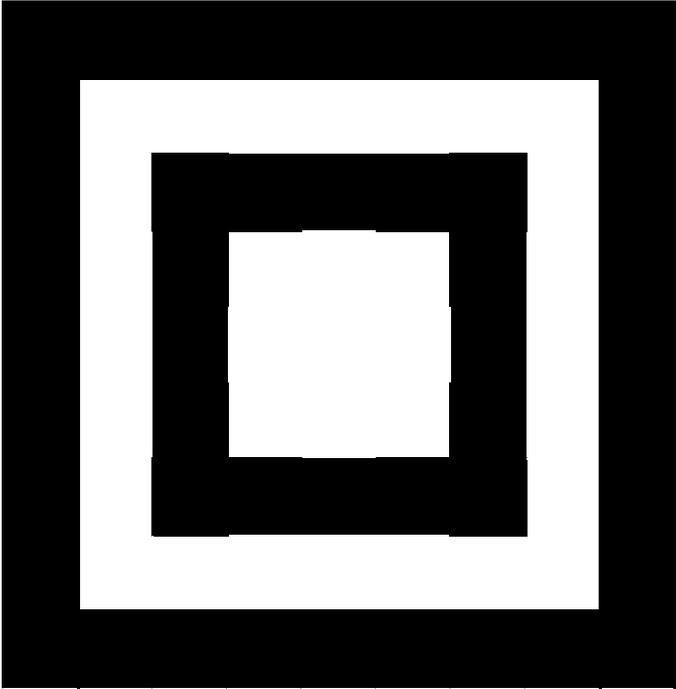


Grid Pattern 3

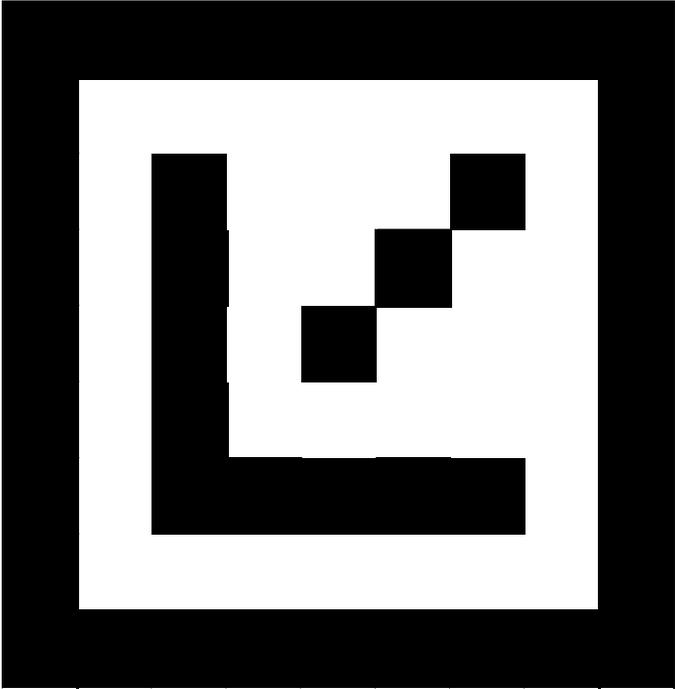


Grid Pattern 4

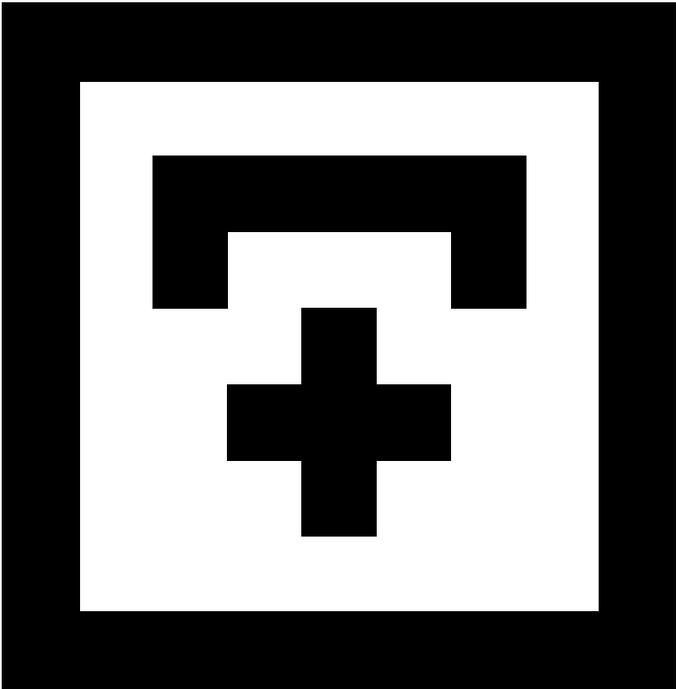
Grid Pattern Collection



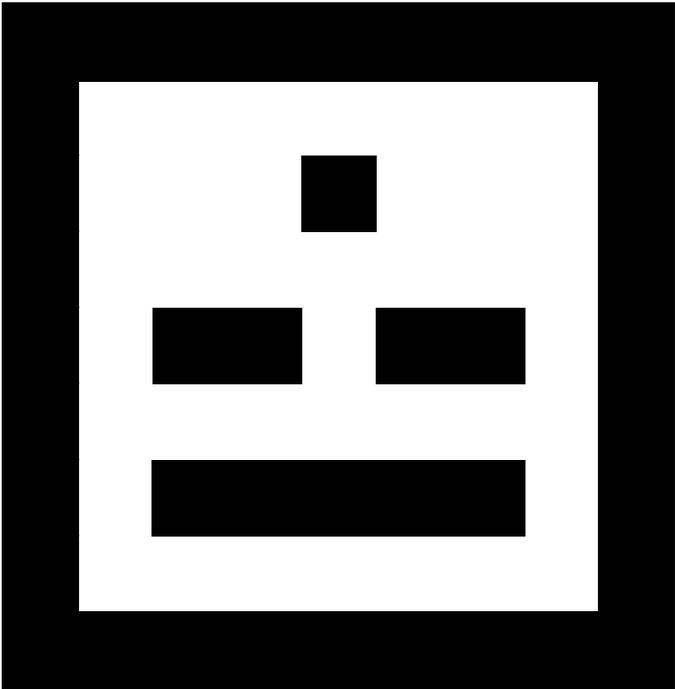
Grid Pattern 5



Grid Pattern 6

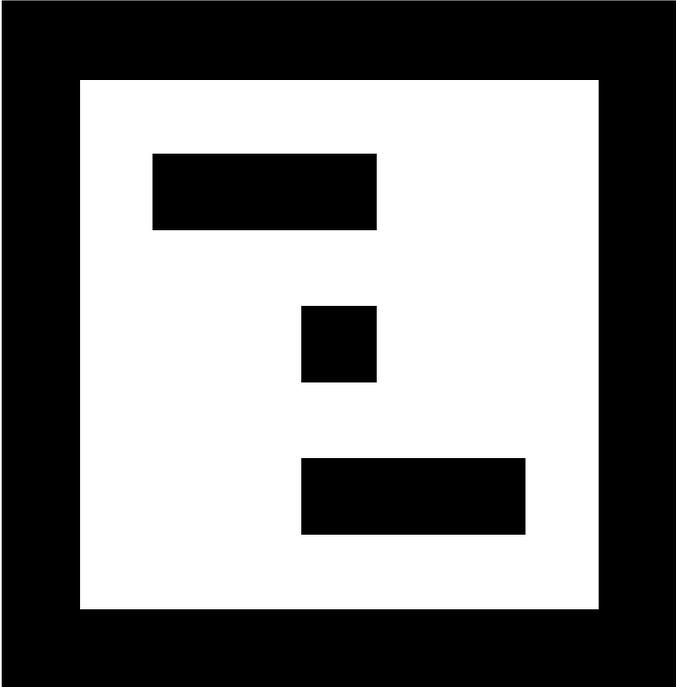


Grid Pattern 7

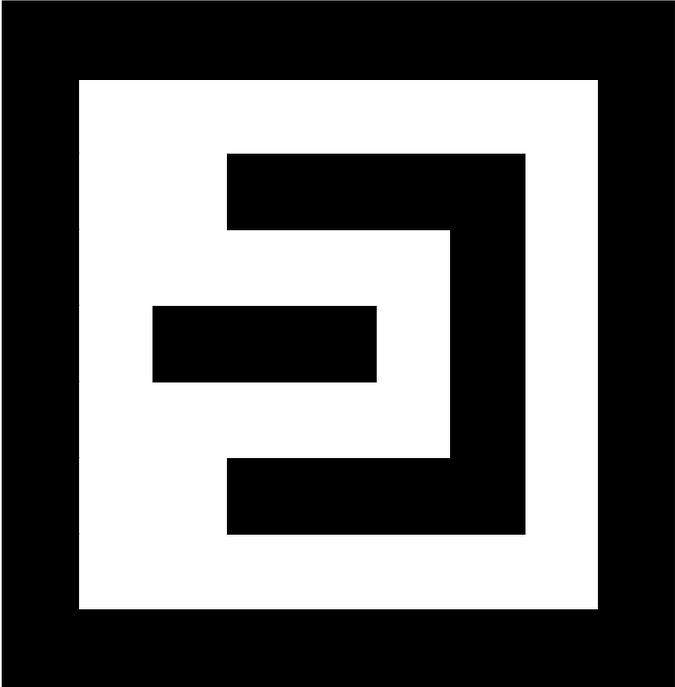


Grid Pattern 8

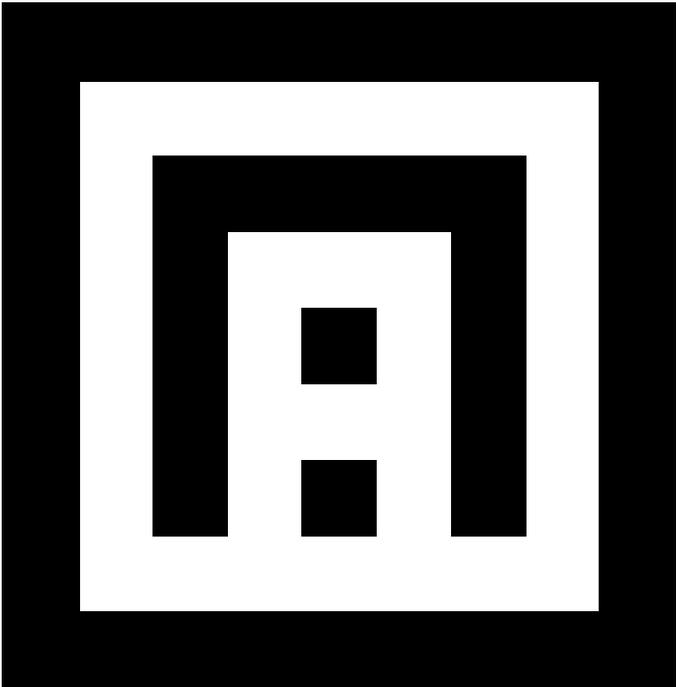
Grid Pattern Collection



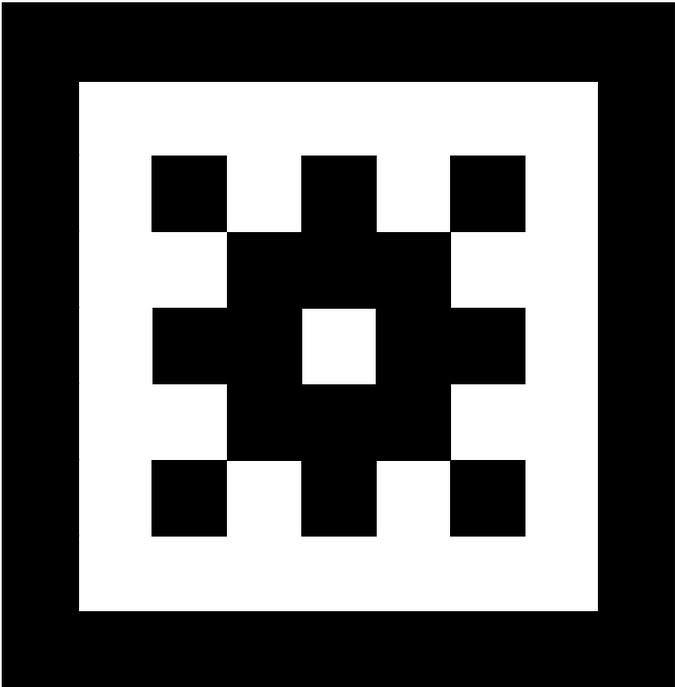
Grid Pattern 9



Grid Pattern 10

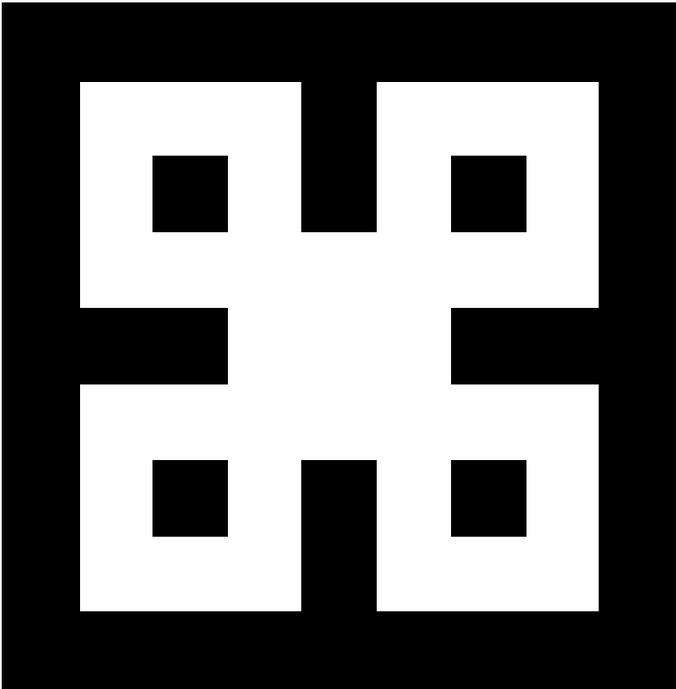


Grid Pattern 11

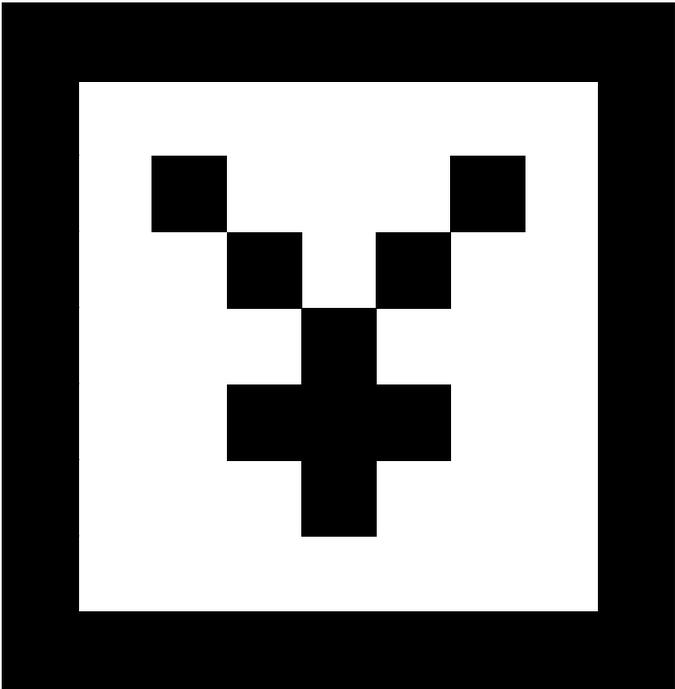


Grid Pattern 12

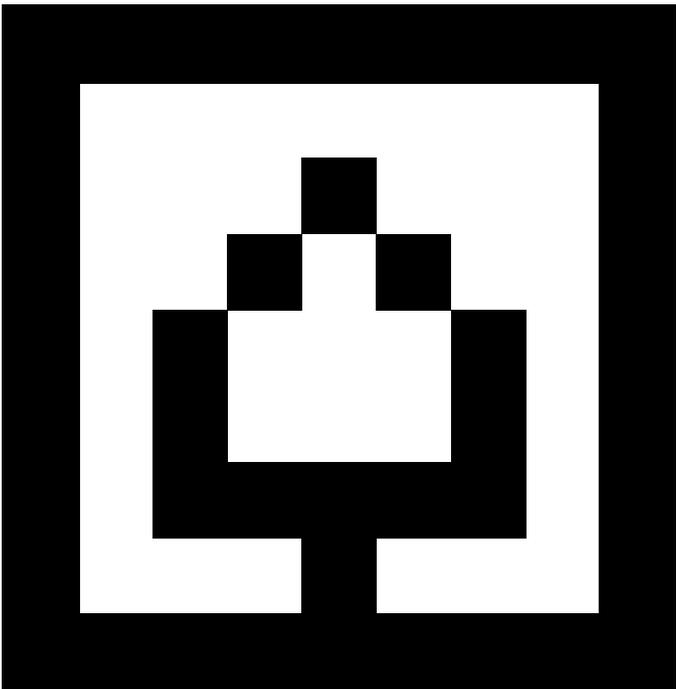
Grid Pattern Collection



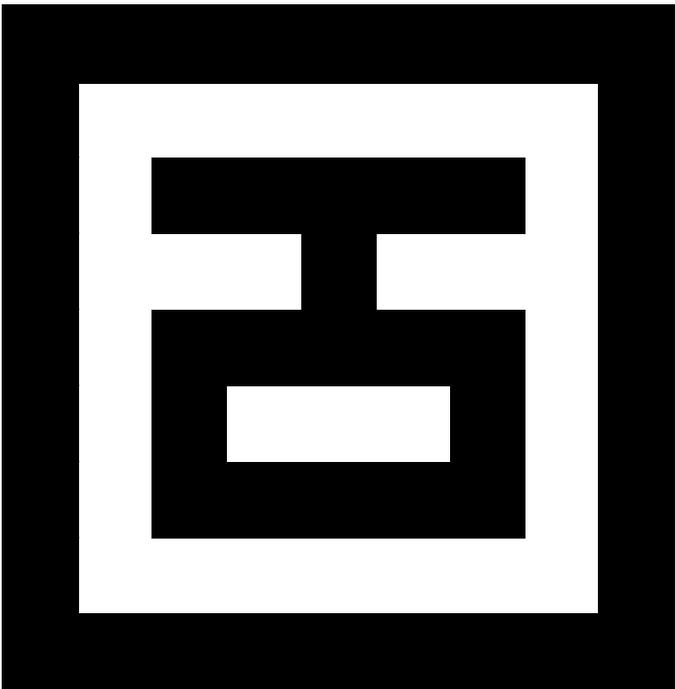
Grid Pattern 13



Grid Pattern 14



Grid Pattern 15



Grid Pattern 16