



CSARC
COMPUTER SCIENCE &
ROBOTICS CERTIFICATION

**Certification in LEGO® Robotics for Learners
Examination Syllabus**

Updated: 3 Oct 2023

Introduction

The **Certification in LEGO® Robotics for Learners** aims to provide a standardised skill benchmark for LEGO based robotics systems, in particular the LEGO® Mindstorms® Education EV3 (45544) and LEGO® Education SPIKE™ Prime (45678). The certification is meant to be platform agnostic and the focus is on testing candidates on core skills in programming, LEGO-based mechanical design, and mission-based problem solving.

Assessment Objectives Overview

1. Programming Theory

Candidates should be able to demonstrate proficiency in:

- 1.1 Usage of single If-Else conditional structure.
- 1.2 Usage of single conditional loop.
- 1.3 Usage of single for loop and forever loop
- 1.4 Usage of nested If-Else conditional structure.
- 1.5 Usage of nested conditional loop.
- 1.6 Usage of variables and math operations.
- 1.7 Implementation of user-defined functions.

2. Robot Building

Candidates should be able to demonstrate proficiency in:

- 2.1 Constructing a LEGO robot with 2 motors by following a graphical construction manual.
- 2.2 Constructing a LEGO robot with 2 motors without a construction manual.
- 2.3 Mounting sensor attachment.
- 2.4 Mounting motor attachment.

3. Practical Programming

Candidates should be able to solve a mission-based problem involving:

- 3.1 Precise motor movement paths.
- 3.2 Line following with single colour sensor.
- 3.3 Line following with multiple colour sensors and overcoming line junctions.
- 3.5 Error correction algorithms.
- 3.6 Data collection and respond to random set of playfield elements.



Scheme of Assessment

1. Certificate Tiers

- 1.1 Each grade examination has a maximum possible score of 25.
- 1.2 Candidates will be issued a certificate if they meet the passing score requirement.
- 1.3 Certificates have different tier levels based on the score requirements as set out in **Table 1:**
Certificate Tier Levels

Table 1: Certificate Tier Levels

Score Requirement	Certificate Tier
≥ 13	Pass
≥ 16	Merit
≥ 20	Distinction
≥ 23	High Distinction

2. Examination Format

- 2.1 The format of each grade examination will follow a score weightage as set out in **Table 2:**

Table 2: Examination Format and Weightage

Assessment Criteria	Grade 1	Grade 2 & 3
Programming Theory questions Interpreting programs or spotting mistakes with a given program	5	5
Robot Building Designing and building a robot with appropriate attachments to effectively complete a task	10	5
Practical Programming Mission solving task with score awarded when candidates successfully demonstrate completion of mission tasks.	10	15



Certificate Examination Syllabus by Grade

Grade 1

Programming Theory	
1.1	<p>Usage of Move Tank blocks to make precise movement</p> <ul style="list-style-type: none"> • Movement by motor degrees/rotations and time <p>Understand difference between distance and speed</p>
1.2	<p>Move tank blocks for precise turns</p> <ul style="list-style-type: none"> • Turning on one wheel • Turning in a wide arc • Turning on the spot
1.3	<p>Usage of If-Else (Switch Block)</p> <ul style="list-style-type: none"> • Single sensor/motor/button logic condition • Logic operators: >, <, =
1.4	<p>Usage of Conditional/Infinite loop</p> <ul style="list-style-type: none"> • Single sensor/motor/button logic condition • Logic operators: >, <, =
Robot Building	
2.1	<p>Constructing a LEGO robot with 2 motors</p> <ul style="list-style-type: none"> • Scores will be awarded as per construction rubrics
2.3	<p>Mounting sensor attachment</p> <ul style="list-style-type: none"> • Sensor has to be mounted at appropriate location and orientation on the robot • Sensor has to be mounted securely and not be loose / shaky
Practical programming	
3.1	<p>Precise motor movement paths (Hardcoded)</p>
3.2	<p>Line following with single colour sensor</p> <ul style="list-style-type: none"> • Usage of single light sensor to follow a line accurately
3.3	<p>Distance/Ultrasonic Sensor</p> <ul style="list-style-type: none"> • Usage of distance/ultrasonic sensor to detect objects • Usage of If-Else block
3.4	<p>Force/Touch Sensor</p> <ul style="list-style-type: none"> • Usage of force/touch sensor to detect objects • Usage of If-Else block



Grade 2

Programming Theory	
1.1	Usage of Move Tank blocks <ul style="list-style-type: none"> • “Off” mode for motor braking • “On” mode for continuous looped movement
1.2	Usage of nested If-Else conditional structure <ul style="list-style-type: none"> • Sensor/motor/button logic condition • Logic operators: >, <, =
1.3	Usage of single conditional loop <ul style="list-style-type: none"> • Single sensor/motor/button logic condition • Logic operators: >, <, =
1.4	Usage of delays (Wait Block)
Robot Building	
2.1	Constructing a LEGO robot with 2 motors <ul style="list-style-type: none"> • Scores will be awarded as per construction rubrics
2.3	Non Motorised Grabbing Device/Attachment <ul style="list-style-type: none"> • Building grabbing device to correct dimensions to capture objective block • Mounting at appropriate height
Practical programming	
3.1	Line Following With 2 Light/Colour Sensors <ul style="list-style-type: none"> • Movement at appropriate speed to ensure accuracy • Following line for a certain time/distance using conditional loops • Navigation of Junctions
3.2	Movement with Conditional Loops <ul style="list-style-type: none"> • Forward or turning movement that will stop based on sensor conditions



Grade 3

Programming Theory	
1.1	<p>Proportional Error Correction Program</p> <ul style="list-style-type: none"> • Concept of proportional guidance (Using difference between destination and location to make proportionate motor correction) • Turning the robot to face a bearing using gyro and error correction • Making robot move forward while accurately facing a bearing using gyro and error correction • Following a line using light/colour sensor and error correction
1.2	<p>Usage of Mathematics block and Variables</p> <ul style="list-style-type: none"> • Addition/Subtraction/Multiplication/Division • Usage of Math block in conjunction with variables to record data points
Robot Building	
2.1	<p>Constructing a LEGO robot with 2 motors</p> <ul style="list-style-type: none"> • Scores will be awarded as per construction rubrics
2.3	<p>Motorised Grabbing Device/Attachment</p> <ul style="list-style-type: none"> • Building a motorised grabbing device appropriate for collection of scoring element • Stable mounting of the grabbing device on the robot
Practical programming	
3.1	<p>Proportional Error Correction Program</p> <ul style="list-style-type: none"> • Use Gyro or Light/Colour sensor, whichever the mission requires for navigation
3.2	<p>Colour Scanning</p> <ul style="list-style-type: none"> • Scanning colour of objective cubes • Cube to be brought to different objective locations based on colour
3.3	<p>Variables and Mathematics</p> <ul style="list-style-type: none"> • Formula will be provided • Using variables to record inputs from sensors • Using math block to calculate output

