La Salle College
Robotics Team
2025-2026

Aptitude Test

Date: 2 October, 2025
Time Allowed: 60 minutes

Instructions

- Welcome! This test is NOT for kicking you out. Do NOT cry after finishing this paper.
- Do **NOT** open the test paper until you are instructed to do so.
- This paper consists of **EIGHT** sections.

Section A	Compulsory (40%)	
Section E1	Choose THREE out of SIX (30%)	Mechanical Engineering
Section E2		Electrical Engineering
Section E3		Automation
Section E4		Robot Control
Section E5		Presentation Skills and Creativity
Section E6		Programming / Coding
Section X	Advanced Challenging Integrated Skills (Not printed to save the Earth)	

- For those who want to push yourself, just raise up you hand for the Special Advanced Challenging Paper. (Mr. Terry LAM insists he is "retired" from attempting it, but you may prove him wrong.)
- No Calculators. No AI. No Internet. No Computer / Device throughout the test.
- Try your best to answer ALL questions. Creativity may bring extra marks.
- If any diagrams are unclear, please ask your nearest invigilator to show the relevant image.
- **Do NOT take away the test paper.**

Full Name		Class		Class Number	
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WhatsApp Phone No.					
Discord Handle					

SECTION **A** **All** students must finish this section. No computer and AI are allowed in this section.

Section A(1) Robotics Fundamentals and Engineering Concepts

Multiple Choice (1 mark each)

1. What is the main purpose of a robot?
   A. To be a toy
   B. To perform tasks automatically
   C. To watch movies
   D. To only be used in factories

2. Which part of a robot is like its "brain," making decisions and controlling everything?
   A. The battery
   B. The motor
   C. The microcontroller
   D. The camera

3. If you want your robot to know how far it is from a wall, which sensor would be best?
   A. A temperature sensor
   B. An ultrasonic sensor
   C. A color sensor
   D. A microphone

4. Which of these is an actuator which makes the robot moving?
   A. A switch
   B. An LED light
   C. A motor
   D. A distance sensor

5. In programming, what is a "loop" used for?
   A. To make the robot stop
   B. To ask a yes/no question
   C. To repeat a set of commands
   D. To store a number

6. An "if-then-else" statement helps a robot to
   A. Move in a circle
   B. Make a decision based on a condition
   C. Remember its starting position
   D. Speed up

7. Why is it a good idea to add comments to your code?
   A. To make the code run faster
   B. To help humans understand what the code does
   C. To give the robot more power
   D. To check for spelling mistakes

8. A byte has 8 bits. How many bits are in 1 megabyte (MB)?
   A. 8
   B. 8000
   C. 8192
   D. 8 000 000

9. To make an underwater robot (ROV) float up without using its thrusters, you should
   A. Add more metal weights
   B. Make it smaller
   C. Add something that floats, like foam / floating bar
   D. Use a stronger battery

10. In a circuit, the current only flows when…
   A. The circuit is open
   B. The circuit is closed
   C. The circuit is in parallel
   D. The power source is Direct Current (DC).

11. Which of the following pins CAN one apply an `analogWrite()` function to on an Arduino board?
   A. AREF (Analog Reference) pin
   B. PWM (Pulse Width Modulation) pin
   C. SCL (Serial Data Clock) pin
   D. TX0 (Transmit 0, Default UART) pin

12. Why should we add a fuse to a circuit?
   A. To increase its maximum rated voltage
   B. To reduce the current for the output device
   C. To protect the circuit from overloading
   D. To make the power source waterproof

13. Why should output devices (e.g. motors on a robot) NOT be wired in SERIES but in PARALLEL?
   A. If a motor breaks down in a series network, everything will be unusable.
   B. Motors wired in serial consume more electricity than motors wired in parallel.
   C. It is harder to replace a motor wired in series than in parallel.
   D. It is more expensive to find a power source for a circuit in series than in parallel.

14. Suggest why (a large amount of) AA batteries cannot be used to power a vehicle.
   A. The final voltage will only be 1.5V
   B. The AA batteries will run dry very soon.
   C. The current will not be enough to start the car.
   D. The AA batteries cannot be recharged at all.

15. In programming, if you want to store a person's age as a whole number (e.g., 13), which data type would be most suitable?
   A. String
   B. Boolean
   C. Integer
   D. Float

16. What is the main purpose of a resistor in an electronic circuit?
   A. To generate light
   B. To store electrical charge
   C. To turn the circuit on and off
   D. To reduce or control the flow of current

17. Underwater robots are often built with a smooth, curved, and streamlined shape. Why is this?
   A. To make them look more modern
   B. To help them sink faster
   C. To reduce water resistance (drag) so they can move more easily
   D. To make them easier to paint

SECTION **A** **All** students must finish this section. No computer and AI are allowed in this section.

18. If a small gear is used to turn a much larger gear, the large gear will spin:

    A. Faster, but with less turning force (torque)
    B. Slower, but with more turning force (torque)
    C. At the exact same speed
    D. Backwards and forwards

19. To create a reliable waterproof seal on an electronics enclosure, what is the most effective component to use?
    A. A rubber O-ring or gasket
    B. Strong glue
    C. Waterproof tape on the outside
    D. Extra-tight metal screws

20. If you need a part of your robot to be **flexible** (it can bend without breaking and return to its shape), which material would you choose?
    A. A glass rod
    B. A steel beam
    C. A rubber strip
    D. A dry piece of wood

21. You need to build the main frame for your underwater robot. You want it to be strong, lightweight, and not rust in water. Which material would you choose?
    A. Wood
    B. Steel
    C. Plastic (PVC pipe)
    D. Glass

22. Your robot's code is not working. What is the very first step you should always take to figure out the problem?
    A. Immediately ask your teacher for the answer
    B. Delete all the code and start over
    C. Read through your code line-by-line to look for mistakes
    D. Check if the robot's battery is charged

23. You need to attach a thruster to the underwater robot's frame. You want the connection to be very secure, but you also want to be able to remove it later for repairs. What is the best fastening method to use?
    A. Super glue
    B. Nuts and bolts
    C. Zip ties
    D. Double-sided tape

24. A robot's wheel has a circumference of 20 cm. If the robot moves forward and the wheel makes 5 complete rotations, how far has the robot travelled?
    A. 4 cm
    B. 25 cm
    C. 100 cm
    D. 200 cm

25. Why is it a good practice to test each part of your robot (like a single motor or sensor) as you build it, instead of waiting until the very end?
    A. Because it uses less battery
    B. To make the final robot look cleaner
    C. It's much easier to find and fix a single problem in a small part
    D. Because testing at the end is boring

26. A solid block of a mystery material sinks when placed in water. This tells you that the material is:
    A. Colder than the water
    B. Heavier than the water
    C. More dense than the water
    D. Smoother than the water

27. A small motor is rated for **3 volts**. What is the most likely thing to happen if you connect it directly to a **9-volt** battery?
    A. It will run normally
    B. It will not run at all
    C. It will run much slower than usual
    D. It will spin very fast and likely be damaged or break

28. To make your robot on ground as stable as possible and prevent it from easily tipping over, you should design it to have a
    A. Very high center of gravity
    B. Center of gravity that changes often
    C. Very low center of gravity
    D. Perfectly centered center of gravity

Section A(2) Robotics Skills and Engineering Concepts

Short Questions 4 marks each

29. Your robot's claw needs to pick up a plastic ring from the bottom of a pool. Sketch a simple design for a claw that can open and close to grab the ring.

30. Draw a simple circuit diagram that includes a battery, a switch, a thruster and a motor. Use lines to show how they are connected so that the switch can turn the motor on and off.

31. You wrote a program to make your robot move forward for 3 seconds. When you run it, the robot just spins in a circle. What are **two possible reasons** why this is happening?

END OF SECTION A

SECTION **E** **Elective** Choose THREE sections in this paper. Write your answer in the answer book.

Section E1: Mechanical Engineering

For a competition, your underwater robot (ROV) must be able to pick up a PVC pipe frame from the bottom of the pool. The frame is about 30cm wide and weighs about 1kg underwater. Your ROV must be strong enough to lift it and stable enough not to tip over.

(a) Your team built a robotic arm with plastic gears to lift the PVC frame. However, during testing, when the arm tries to lift the frame, you hear a clicking sound, and the plastic gear teeth are being stripped and damaged. The arm can't lift the weight.
   (i) Identify **one** likely reason why the plastic gears are failing under this load. (2 marks)
   (ii) Propose **two different solutions** to fix this problem and make the arm strong enough to lift the frame. (2 marks)

(b) Suggest a material and method for creating the coverings lids of the watertight compartment. (2 marks)

(c) Would you build the main chassis (frame) of your robot out of Aluminum alloy or 3D-printed plastic (ABS)? Explain your choice by giving one clear advantage of your chosen material for this specific task. (4 marks)

Section E2: Electrical Engineering

Your team wants to add a new, powerful underwater camera to the ROV. The camera requires a **5V** power supply and must be connected to the main electronics board, which is powered by a **12V** battery.

(a) What key electronic component is needed to safely power the 5V camera from the 12V battery? Draw a simple block diagram showing how you would connect the **12V Battery**, this new component, and the **5V Camera**. (4 marks)

(b) Calculate the energy used if a camera runs at 5V and 2.4A for 30 minutes in watt-hours. (2 marks)

(c) The camera will be mounted outside the main waterproof electronics box, so its wire must pass through the wall of the box.
   (i) Describe a reliable method to make this wire connection waterproof. (2 marks)
   (ii) Why is simply using hot glue or tape not a good idea for a competition robot? (2 marks)

Section E3: Automation

Your ROV needs to autonomously navigate a simple path. It starts in one corner of a square area in the pool. In the center of the area is a green-colored marker. The ROV must touch the marker and then return to the corner it started from.

(a) To complete this task without a human driver, what types of input would the ROV need? For each input, explain what it would be used for (e.g., "A _____ to _____"). (3 marks)

(b) Write a step-by-step plan (an algorithm) in pseudo-code / C++ / python that describes the logic the robot would follow to complete the mission. Your plan should have at least 5 clear steps. (Example: 1. Dive to a depth of 2 meters. 2. ...) (5 Marks)

(c) What could go wrong if the lighting conditions in the pool change (e.g., the sun gets brighter)? How might this affect your algorithm, and what could you add to your code to handle this problem? (2 marks)

Section E4: Robot Control

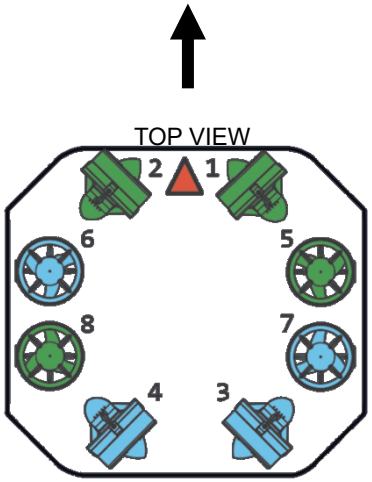
(a) Gyrodos Robotics's inventory has multiple input devices:

Ultrasonic Sensor	Hall Sensor	Piezometer
Rotary Potentiometer	Infrared Sensor	Pressure Sensor
Gyroscope	GPS Detector	Temperature Sensor

(i) Which sensor would be the most reliable to measure water depth? (1 mark)

(ii) Which sensors would fail to produce meaningful input underwater? (1 mark)

You are the pilot for a ROV with four thrusters, as shown in the diagram below. You control the robot using a joystick. The thrusters can push water forwards or backwards. The arrow indicates the "Forward" direction of the ROV.



Spinning a thruster Clockwise (**CW**) produces Forward Thrust (pushes water backward, moving the robot forward).

Spinning a thruster Counter-Clockwise (**CCW**) produces Backward Thrust (pushes water forward, moving the robot backward).

(b) For each movement below, state which thruster(s) (by number) you would need to turn on, and in which direction they should spin.

(i) Move straight forward (2 marks)

(ii) Turn left (while staying in the same spot) (2 marks)

(c) Describe how you would use a combination of horizontal and vertical thrusters to make the robot move diagonally forward and to the right, while also diving deeper at the same time. (4 marks)

Section E5: Presentation Skills and Creativity

Your answer must be very creative in order to get full mark in this section.

The MATE/ROV competition encourages teams to create innovative solutions to problems. The theme this year is "Ocean Conservation," and one task involves collecting delicate biological samples (like coral fragments) from the sea floor without damaging them.

(a) Instead of a simple claw, design a unique tool or mechanism for your ROV that is specifically designed to handle delicate samples.

Sketch your idea on paper. Give your tool a creative name.

Write a short paragraph (3-4 sentences) describing what it does and how it works. (6 marks)

(b) Explain why your design is better for collecting delicate samples than a standard, simple two-fingered claw. What specific features of your design prevent damage to the samples? (4 marks)

Section E6: Programming

```
1  def __init__(self):
2      # Initializes the ROV. Thruster speeds are from -100 (full reverse) to 100 (full forward).
3      self.thruster_left_speed = 0
4      self.thruster_right_speed = 0
5      self.target_depth = 1.5                # Target depth in meters
6
7  def set_movement(self, forward_power, turn_power):
8      # Sets thruster speeds based on joystick input
9      # forward_power and turn_power are between -100 and 100
10     self.thruster_left_speed = forward_power + turn_power
11     self.thruster_right_speed = forward_power - turn_power
12
13     # Clamping the values to be within [-100, 100]
14     if self.thruster_left_speed > 100: self.thruster_left_speed = 100
15     if self.thruster_left_speed < -100: self.thruster_left_speed = -100
16     if self.thruster_right_speed > 100: self.thruster_right_speed = 100
17     if self.thruster_right_speed < -100: self.thruster_right_speed = -100
18
19 def maintain_depth(self, current_depth):
20     # Adjusts vertical thrusters to hold a target depth
21     error = self.target_depth - current_depth
22     correction_speed = error * 50  # Proportional control
23
24     if error > 0.1:
25     # Too high, need to go down
26         print("INFO: Diving. Error: {error:.2f}")
27         return correction_speed  # Positive speed means dive
28     elif error < -0.1:
29         # Too low, need to go up
30         print("INFO: Surfacing. Error: {error:.2f}")
31         return correction_speed  # Negative speed means surface
32     else:
33         # Depth is good
34         return 0
35
36 # --- Main Program Loop ---
37 rov = ROVController()
38 # Assume read_depth_sensor() is a function that returns the current depth in meters.
39
40 while True:
41     current_depth = read_depth_sensor()
42     vertical_thrust = rov.maintain_depth(current_depth)
43     # Here, we would send the vertical_thrust value to the vertical thrusters.
44     # We would also read joystick values and call rov.set_movement(...)
45
```

(a) What is the primary purpose of the `__init__` function (line 1)? (1 mark)

(b) If the command `rov.set_movement(80,20)` is executed, what will the final speed of the **right thruster** be? (1 mark)

(c) In the `maintain_depth` function, if the ROV's `current_depth` is 1.2 meters, what will be the value of `correction_speed`? (1 mark)

(d) What condition will cause the program to print "`INFO: Surfacing.`"? (1 mark)

(e) What problem does the code in line 13 – 17 prevent? (1 mark)

(f) What does a **negative** value for `error` signify? (1 mark)

(g) During a test, you notice the ROV is oscillating up and down too aggressively when trying to maintain depth. It overshoots the target depth in both directions. Identify the **one line** of code you would most likely need to adjust to make this movement gentler. Suggest a new value for that line and explain why your change would work. (2 marks)

(h) You need to add a safety feature. If the ROV goes **deeper than 3.0 meters**, it should immediately stop all thrusters for safety. Add Python code inside the `while True:` loop after line 45 to implement this check. (2 marks)

END OF PAPER