

# GATE Robotics and Automation (RA)

## Sample Paper – 1

Duration: 180 Minutes

Maximum Marks: 100

### Instructions

- This paper is modelled on the **GATE Robotics and Automation (RA)** paper structure.
- Attempt **General Aptitude, Part A**, and either **Part B1 Electrical** or **Part B2 Mechanical**.
- General Aptitude carries **15 marks**, Part A carries **60 marks**, and the chosen optional section carries **25 marks**.
- Question types are **MCQ, MSQ**, and **NAT**. Questions carry either **1 mark** or **2 marks**.
- Negative marking applies only to wrong MCQs: **1/3 mark** for 1-mark MCQs and **2/3 mark** for 2-mark MCQs.
- There is **no negative marking** for MSQ or NAT questions. MSQ questions have **no partial marking**.

### General Aptitude - Compulsory

**GA1. [MCQ, 1 mark]** Choose the grammatically correct sentence.

- (A) The robot is calibrated.
- (B) The robot are calibrated.
- (C) The robots is calibrating.
- (D) The robot have calibrated.

**GA2. [MCQ, 1 mark]** Sensor is to measurement as actuator is to:

- (A) Control signal
- (B) Motion
- (C) Noise



(D) Memory

**GA3. [NAT, 1 mark]** A motor costs Rs. 8000 after a 20 percent discount. What was the marked price in rupees? *Answer type: Numerical Answer Type (enter the value).*

**GA4. [MCQ, 1 mark]** All cobots are robots. Some robots are mobile. Which conclusion necessarily follows?

- (A) All cobots are mobile
- (B) Some mobile systems are cobots
- (C) Every cobot is a robot
- (D) No cobot is mobile

**GA5. [NAT, 1 mark]** The mean of 4, 6, 10 and  $x$  is 8. Find  $x$ . *Answer type: Numerical Answer Type (enter the value).*

**GA6. [MCQ, 2 marks]** A project is completed by 6 identical robots in 10 hours. Assuming ideal scaling, how long will 15 robots take?

- (A) 2 h
- (B) 3 h
- (C) 5 h
- (D) 4 h

**GA7. [NAT, 2 marks]** A controller update time is reduced from 25 ms to 20 ms. What is the percentage reduction? *Answer type: Numerical Answer Type (enter the value).*

**GA8. [MCQ, 2 marks]** A sensor gives readings 9.8, 10.1, 10.0 and 10.1 mm. The range of the readings is:

- (A) 0.3 mm
- (B) 0.2 mm



(C) 0.1 mm

(D) 0.4 mm

**GA9. [MCQ, 2 marks]** A factory claims energy use fell after installing robots. Which data best supports the claim?

(A) Robot colour changed

(B) Energy per unit product decreased

(C) Production manager changed

(D) More operators joined

**GA10. [NAT, 2 marks]** A box has 3 good sensors and 2 defective sensors. One sensor is chosen at random. The probability that it is defective is: *Answer type: Numerical Answer Type (enter the value).*

**Part A - Common Robotics and Automation Section**

**A1. [NAT, 1 mark]** For matrix  $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ , find the determinant. *Answer type: Numerical Answer Type (enter the value).*

**A2. [MCQ, 1 mark]** The rank of a 3 x 3 identity matrix is:

(A) 3

(B) 1

(C) 2

(D) 0

**A3. [NAT, 1 mark]** If  $f(x) = x^3$ , find  $f'(2)$ . *Answer type: Numerical Answer Type (enter the value).*

**A4. [NAT, 1 mark]** Evaluate the definite integral of  $2x$  from 0 to 3. *Answer type: Numerical Answer Type (enter the value).*

**A5. [MCQ, 1 mark]** The solution of  $dy/dt + 2y = 0$  is proportional to:



- (A)  $e^{(2t)}$
- (B)  $e^{(-2t)}$
- (C)  $t^2$
- (D)  $\sin 2t$

- A6. [NAT, 1 mark]** A fair die is rolled once. Probability of getting an even number is: *Answer type: Numerical Answer Type (enter the value).*
- A7. [MCQ, 1 mark]** The trapezoidal rule approximates an integral by using:
- (A) Circular arcs
  - (B) Only random samples
  - (C) Straight-line segments
  - (D) Boolean gates
- A8. [NAT, 1 mark]** A 10 V source is connected across a 5 ohm resistor. The current in amperes is: *Answer type: Numerical Answer Type (enter the value).*
- A9. [NAT, 1 mark]** For  $R = 2 \text{ kohm}$  and  $C = 5 \text{ microfarad}$ , the RC time constant in milliseconds is: *Answer type: Numerical Answer Type (enter the value).*
- A10. [MCQ, 1 mark]** Thevenin's theorem replaces a linear two-terminal network by:
- (A) A current source only
  - (B) A transformer only
  - (C) A capacitor only
  - (D) A voltage source in series with resistance
- A11. [MCQ, 1 mark]** The Boolean expression  $A + A'B$  simplifies to:
- (A)  $A + B$
  - (B)  $AB$



(C)  $A' + B$

(D) 0

**A12. [NAT, 1 mark]** How many select lines are required for an 8-to-1 multiplexer? *Answer type: Numerical Answer Type (enter the value).*

**A13. [MCQ, 1 mark]** A Hall-effect sensor is commonly used to measure:

(A) pH only

(B) Magnetic field

(C) Humidity only

(D) Sound intensity only

**A14. [MSQ, 1 mark]** Which of the following can be used as displacement transducers?

(A) LVDT

(B) Rotary encoder

(C) Strain gauge bridge for torque only

(D) Capacitive displacement sensor

**A15. [NAT, 1 mark]** A stepper motor has 200 full steps per revolution. Its full-step angle in degrees is: *Answer type: Numerical Answer Type (enter the value).*

**A16. [MCQ, 1 mark]** In a DC motor, back emf is primarily proportional to:

(A) Shaft length only

(B) Brush colour

(C) Speed

(D) Ambient light



- A17. [NAT, 1 mark]** A 50 N block on a horizontal surface has coefficient of friction 0.2. Limiting friction in newtons is: *Answer type: Numerical Answer Type (enter the value).*
- A18. [NAT, 1 mark]** In Python, what is the value of `len([2, 4, 6, 8])`? *Answer type: Numerical Answer Type (enter the value).*
- A19. [MCQ, 1 mark]** A stack follows which access rule?
- (A) FIFO
  - (B) Shortest path
  - (C) Random only
  - (D) LIFO
- A20. [MCQ, 1 mark]** Inorder traversal of a binary search tree gives keys in:
- (A) Sorted nondecreasing order
  - (B) Decreasing order always
  - (C) Random order
  - (D) Level order only
- A21. [MCQ, 2 marks]** A 2D rotation of 90 degrees counterclockwise maps point (1, 0) to:
- (A) (1, 0)
  - (B) (0, 1)
  - (C) (0, -1)
  - (D) (-1, -1)
- A22. [MCQ, 2 marks]** A pure translation by (3, 0) is applied to point (2, 1). The transformed point is:
- (A) (2, 4)
  - (B) (3, 2)



(C) (5, 1)

(D) (1, 5)

**A23. [MCQ, 2 marks]** A planar 2R arm has link lengths 1 m and 1 m, with  $q_1 = 0$  degrees and  $q_2 = 90$  degrees. The end point is:

(A) (2, 0)

(B) (0, 2)

(C) (-1, 1)

(D) (1, 1)

**A24. [NAT, 2 marks]** A serial robot with six independent revolute joints normally has how many degrees of freedom? *Answer type: Numerical Answer Type (enter the value).*

**A25. [MCQ, 2 marks]** The manipulator Jacobian relates joint rates to:

(A) End-effector velocity

(B) Link colour

(C) Gear tooth number only

(D) PLC memory address

**A26. [MCQ, 2 marks]** A robot repeatedly reaches the same wrong point. This indicates high:

(A) Accuracy only

(B) Repeatability but poor accuracy

(C) Both poor repeatability and poor precision

(D) Payload only

**A27. [MSQ, 2 marks]** Which tasks generally require continuous path control?

(A) Arc welding

(B) Spray painting



- (C) Pick-and-place between two fixed points only
- (D) Seam sealing

**A28. [MCQ, 2 marks]** In a PLC ladder diagram, a normally open contact conducts logically when its associated input is:

- (A) Missing
- (B) FALSE
- (C) TRUE
- (D) Analog only

**A29. [MCQ, 2 marks]** In CNC programming, G01 commonly represents:

- (A) Rapid positioning
- (B) Tool change only
- (C) Spindle stop only
- (D) Linear interpolation at feed rate

**A30. [MCQ, 2 marks]** An automated storage and retrieval system is mainly used for:

- (A) Automated inventory storage and retrieval
- (B) Manual chalk marking
- (C) Increasing backlash
- (D) Measuring pH

**A31. [NAT, 2 marks]** A single-phase load draws 5 A from 100 V at 0.8 power factor. Real power in watts is: *Answer type: Numerical Answer Type (enter the value).*

**A32. [MSQ, 2 marks]** Which are sequential digital circuits?

- (A) D flip-flop
- (B) Counter



- (C) 2-input AND gate
- (D) Register

**A33. [MCQ, 2 marks]** A Wheatstone bridge is commonly used with strain gauges because it:

- (A) Generates hydraulic power
- (B) Converts small resistance changes into measurable voltage
- (C) Stores robot programs
- (D) Performs sorting

**A34. [MCQ, 2 marks]** Pneumatic actuators are usually preferred when the application needs:

- (A) No compressed air
- (B) Very high stiffness only
- (C) Clean and fast motion with moderate force
- (D) Only nanometre positioning

**A35. [NAT, 2 marks]** For a point at radius 0.5 m rotating at 10 rad/s, tangential speed in m/s is: *Answer type: Numerical Answer Type (enter the value).*

**A36. [NAT, 2 marks]** A recursive factorial function returns factorial(4). The returned value is: *Answer type: Numerical Answer Type (enter the value).*

**A37. [MCQ, 2 marks]** In a min-heap, the root node stores:

- (A) Maximum key
- (B) Last inserted key always
- (C) Average key
- (D) Minimum key

**A38. [MCQ, 2 marks]** A spherical wrist is commonly used to provide:



- (A) End-effector orientation control
- (B) Only base translation
- (C) Battery charging
- (D) PLC scan delay

**A39. [NAT, 2 marks]** A 200-step/rev stepper uses 8 microsteps per full step. The microstep angle in degrees is: *Answer type: Numerical Answer Type (enter the value).*

**A40. [MCQ, 2 marks]** A trapezoidal velocity profile contains:

- (A) Only zero velocity
- (B) Acceleration, constant velocity and deceleration phases
- (C) Only random motion
- (D) Only Boolean states



**Part B1 - Electrical Engineering Optional**

- B11. [MCQ, 1 mark]** An ideal low-pass filter allows:
- (A) Low frequencies
  - (B) Only high frequencies
  - (C) No DC component ever
  - (D) Only noise
- B12. [MCQ, 1 mark]** An ideal operational amplifier has:
- (A) Zero input impedance
  - (B) Infinite input impedance
  - (C) Zero open-loop gain
  - (D) Only digital output
- B13. [MCQ, 1 mark]** A Schmitt trigger is useful because it provides:
- (A) Hydraulic pressure
  - (B) Gear reduction
  - (C) Hysteresis
  - (D) Pure integration only
- B14. [NAT, 1 mark]** An 8-bit ADC has how many quantization levels? *Answer type: Numerical Answer Type (enter the value).*
- B15. [MSQ, 1 mark]** Which are typical microcontroller components?
- (A) CPU
  - (B) Timer
  - (C) I/O ports
  - (D) Steam turbine



- B16. [NAT, 2 marks]** For  $R = 1 \text{ kohm}$  and  $C = 0.159 \text{ microfarad}$ , the first-order RC cutoff frequency is approximately how many hertz? Use  $\pi = 3.14$ .  
*Answer type: Numerical Answer Type (enter the value).*
- B17. [MCQ, 2 marks]** For a bandlimited signal with maximum frequency 2 kHz, the sampling frequency must be greater than:
- (A) 1 kHz
  - (B) 2 kHz
  - (C) 0.5 kHz
  - (D) 4 kHz
- B18. [MCQ, 2 marks]** A time delay of  $t_0$  in a signal introduces in its Fourier transform a:
- (A) Phase factor
  - (B) Change from volts to amperes
  - (C) Mechanical torque
  - (D) Binary heap
- B19. [NAT, 2 marks]** A sinusoidal voltage has peak value 10 V. Its RMS value is approximately: *Answer type: Numerical Answer Type (enter the value).*
- B110. [MCQ, 2 marks]** For forward path  $G$  and feedback  $H$ , the standard negative-feedback closed-loop transfer function is:
- (A)  $G/(1-GH)$
  - (B)  $G/(1+GH)$
  - (C)  $H/G$
  - (D)  $1/GH$
- B111. [NAT, 2 marks]** The first column of a Routh array has signs  $+$ ,  $+$ ,  $-$ ,  $+$ . How many sign changes occur? *Answer type: Numerical Answer Type (enter the value).*



- B112. [MCQ, 2 marks]** For a unity-feedback type-1 system, the finite error constant for a ramp input is:
- (A)  $K_p$
  - (B)  $K_a$
  - (C)  $K_v$
  - (D) Damping ratio
- B113. [MCQ, 2 marks]** A single real pole contributes a high-frequency magnitude slope of:
- (A) +20 dB/decade
  - (B) +40 dB/decade
  - (C) 0 dB/decade only
  - (D) -20 dB/decade
- B114. [MCQ, 2 marks]** The derivative term in a PID controller mainly provides:
- (A) Anticipatory damping action
  - (B) Integral windup only
  - (C) Zero phase lead always
  - (D) ADC quantization
- B115. [MCQ, 2 marks]** In discrete-time systems,  $z^{-1}$  represents:
- (A) One-sample advance only
  - (B) One-sample delay
  - (C) Infinite gain
  - (D) Mechanical backlash



**Part B2 - Mechanical Engineering Optional**

**B21. [MCQ, 1 mark]** Normal stress is defined as:

- (A) Voltage per unit current
- (B) Area per unit force
- (C) Velocity per unit time
- (D) Force per unit area

**B22. [MCQ, 1 mark]** A strain gauge is primarily used to measure:

- (A) Humidity only
- (B) Colour
- (C) Strain
- (D) Clock frequency

**B23. [MCQ, 1 mark]** For a simply supported beam with central point load  $P$  and span  $L$ , maximum bending moment is:

- (A)  $PL$
- (B)  $PL/4$
- (C)  $P/L$
- (D)  $4PL$

**B24. [MCQ, 1 mark]** The torsion relation for a circular shaft is:

- (A)  $T/J = \tau/r$
- (B)  $V = IR$
- (C)  $P = VI$
- (D)  $F = ma$  only

**B25. [MCQ, 1 mark]** The main function of a bearing is to:

- (A) Measure pH



- (B) Generate program code
- (C) Store pneumatic air only
- (D) Support relative motion and reduce friction

- B26. [NAT, 2 marks]** A 10 kN load acts on an area of  $100 \text{ mm}^2$ . Normal stress in MPa is: *Answer type: Numerical Answer Type (enter the value).*
- B27. [NAT, 2 marks]** If axial strain is 0.001 and Poisson's ratio is 0.3, magnitude of lateral strain is: *Answer type: Numerical Answer Type (enter the value).*
- B28. [MCQ, 2 marks]** Euler buckling load for a pinned-pinned column is proportional to:
- (A) Only density
  - (B)  $L^2/EI$
  - (C)  $EI/L^2$
  - (D) Only surface colour
- B29. [NAT, 2 marks]** For  $m = 2 \text{ kg}$  and  $k = 200 \text{ N/m}$ , undamped natural frequency in rad/s is: *Answer type: Numerical Answer Type (enter the value).*
- B210. [MCQ, 2 marks]** A gear pair has driver teeth 20 and driven teeth 60. Compared with driver speed, driven speed is:
- (A) Three times higher
  - (B) One-third
  - (C) Same always
  - (D) Zero
- B211. [MCQ, 2 marks]** An S-N diagram is used mainly in:
- (A) Fatigue analysis
  - (B) PLC programming



- (C) ADC conversion
- (D) Boolean minimization

**B212. [MCQ, 2 marks]** The von Mises criterion is commonly used for yielding of:

- (A) Ductile materials
- (B) Only ideal gases
- (C) Only electrical insulation
- (D) Only software strings

**B213. [NAT, 2 marks]** A mass of 0.2 kg rotates at radius 0.1 m and angular speed 10 rad/s. Centrifugal force in newtons is: *Answer type: Numerical Answer Type (enter the value).*

**B214. [MCQ, 2 marks]** Additive manufacturing builds parts mainly by:

- (A) Only forging
- (B) Layer-by-layer material addition
- (C) Only casting in sand
- (D) Random deletion

**B215. [MCQ, 2 marks]** Castigliano's theorem is used to find:

- (A) Sampling frequency
- (B) ADC resolution
- (C) Deflection from strain energy
- (D) PLC scan time



## Detailed Solutions

## General Aptitude - Compulsory

GA1.

## Solution

**Concept — Verbal Aptitude:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The subject 'robot' is singular, so the correct verb is 'is'.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to GA1](#)

GA2.

## Solution

**Concept — Verbal Analogy:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A sensor measures a physical quantity; an actuator converts a command into physical motion or force.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to GA2](#)

GA3.

## Solution

**Concept — Quantitative Aptitude:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** If marked price is M, then  $0.8M = 8000$ . Hence  $M = 10000$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (10000) [Go Back to GA3](#)



GA4.

**Solution**

**Concept — Logical Reasoning:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The first statement directly says that every cobot belongs to the class of robots.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to GA4](#)

GA5.

**Solution**

**Concept — Statistics:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Mean =  $(4 + 6 + 10 + x)/4 = 8$ , so  $20 + x = 32$  and  $x = 12$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (12) [Go Back to GA5](#)

GA6.

**Solution**

**Concept — Quantitative Aptitude:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Total work =  $6 \times 10 = 60$  robot-hours. Time with 15 robots =  $60/15 = 4$  hours.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to GA6](#)



GA7.

**Solution**

**Concept — Percentages:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Reduction = 5 ms. Percentage reduction =  $5/25 \times 100 = 20$  percent.

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (20) [Go Back to GA7](#)

GA8.

**Solution**

**Concept — Data Interpretation:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Range = maximum - minimum =  $10.1 - 9.8 = 0.3$  mm.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to GA8](#)

GA9.

**Solution**

**Concept — Critical Reasoning:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Energy per unit product directly measures energy efficiency and supports the claim.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to GA9](#)



GA10.

**Solution**

**Concept — Probability:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** There are 2 defective sensors out of 5 total sensors. Probability =  $2/5 = 0.4$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (0.4) [Go Back to GA10](#)

**Part A - Common Robotics and Automation Section**

A1.

**Solution**

**Concept — Linear Algebra:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Determinant =  $1 \times 4 - 2 \times 3 = -2$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (-2) [Go Back to A1](#)

A2.

**Solution**

**Concept — Linear Algebra:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** All three rows and columns are linearly independent, so the rank is 3.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to A2](#)



A3.

**Solution**

**Concept — Calculus:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $f'(x) = 3x^2$ . Therefore  $f'(2) = 12$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (12) [Go Back to A3](#)

A4.

**Solution**

**Concept — Calculus:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Integral of  $2x$  is  $x^2$ . Value from 0 to 3 is 9.

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (9) [Go Back to A4](#)

A5.

**Solution**

**Concept — Differential Equations:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The homogeneous first-order equation has solution  $y = C e^{(-2t)}$ .

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to A5](#)



A6.

**Solution**

**Concept — Probability:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Even outcomes are 2, 4 and 6. Probability =  $3/6 = 0.5$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to A6](#)

A7.

**Solution**

**Concept — Numerical Methods:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The rule joins adjacent function values by straight-line segments and sums trapezoid areas.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to A7](#)

A8.

**Solution**

**Concept — Networks:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** By Ohm's law,  $I = V/R = 10/5 = 2$  A.

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to A8](#)



A9.

**Solution**

**Concept — Transient Circuits:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $RC = 2000 \times 5 \times 10^{-6} = 0.01 \text{ s} = 10 \text{ ms}$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (10) [Go Back to A9](#)

A10.

**Solution**

**Concept — Network Theorems:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Thevenin equivalent consists of a voltage source in series with an equivalent resistance.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to A10](#)

A11.

**Solution**

**Concept — Digital Circuits:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Using absorption,  $A + A'B = (A + A')(A + B) = A + B$ .

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to A11](#)



A12.

**Solution**

**Concept — Digital Circuits:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** An 8-to-1 multiplexer needs  $\log_2(8) = 3$  select lines.

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (3) [Go Back to A12](#)

A13.

**Solution**

**Concept — Sensors:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Hall voltage is produced by charge carriers in a magnetic field, so Hall sensors measure magnetic field or related quantities.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to A13](#)

A14.

**Solution**

**Concept — Sensors:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** LVDTs, encoders and capacitive sensors are common displacement or position transducers.

**Question Type:** MSQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (ABD) [Go Back to A14](#)



A15.

**Solution**

**Concept — Actuators:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Step angle =  $360/200 = 1.8$  degrees.

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (1.8) [Go Back to A15](#)

A16.

**Solution**

**Concept — Actuators:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Back emf is proportional to angular speed for a given field flux.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to A16](#)

A17.

**Solution**

**Concept — Engineering Mechanics:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Limiting friction =  $\mu N = 0.2 \times 50 = 10$  N.

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (10) [Go Back to A17](#)



A18.

**Solution**

**Concept — Programming:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The list contains four elements.

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (4) [Go Back to A18](#)

A19.

**Solution**

**Concept — Data Structures:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A stack is last-in-first-out.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to A19](#)

A20.

**Solution**

**Concept — Data Structures:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** For a BST, inorder traversal visits left subtree, node and right subtree, producing sorted order.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to A20](#)



A21.

**Solution**

**Concept — Rotation Matrices:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The standard 90 degree counterclockwise rotation matrix maps the x-axis unit vector to the y-axis unit vector.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to A21](#)

A22.

**Solution**

**Concept — Homogeneous Transformations:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Translation adds the displacement to the point:  $(2 + 3, 1 + 0) = (5, 1)$ .

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to A22](#)

A23.

**Solution**

**Concept — Forward Kinematics:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The first link ends at (1,0). The second link is oriented at 90 degrees, adding (0,1). End point = (1,1).

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to A23](#)



A24.

**Solution**

**Concept — Robot DOF:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Each independent revolute joint contributes one degree of freedom, so total DOF = 6.

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (6) [Go Back to A24](#)

A25.

**Solution**

**Concept — Robot Jacobian:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The Jacobian maps joint velocity vector to linear and angular velocity of the end-effector.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to A25](#)

A26.

**Solution**

**Concept — Accuracy and Repeatability:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Repeatedly reaching the same point means high repeatability, but the point is wrong, so accuracy is poor.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to A26](#)



A27.

**Solution**

**Concept — Robot Control:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Arc welding, spray painting and seam sealing require the tool to follow a continuous path.

**Question Type:** MSQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (ABD) [Go Back to A27](#)

A28.

**Solution**

**Concept — PLC:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A normally open contact closes in logic when the corresponding input condition is true.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to A28](#)

A29.

**Solution**

**Concept — CNC:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** G01 is the standard code for linear interpolation using the programmed feed rate.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to A29](#)



A30.

**Solution**

**Concept — ASRS:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** ASRS automates placement, storage and retrieval of goods in racks or storage locations.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to A30](#)

A31.

**Solution**

**Concept — AC Circuits:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $P = VI \cos(\phi) = 100 \times 5 \times 0.8 = 400 \text{ W}$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (400) [Go Back to A31](#)

A32.

**Solution**

**Concept — Sequential Logic:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Flip-flops, counters and registers store state; an AND gate is purely combinational.

**Question Type:** MSQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (ABD) [Go Back to A32](#)



A33.

**Solution**

**Concept — Signal Conditioning:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A bridge circuit is sensitive to small resistance changes and converts them into voltage imbalance.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to A33](#)

A34.

**Solution**

**Concept — Actuators:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Pneumatics are common for fast, clean, moderate-force industrial motions.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to A34](#)

A35.

**Solution**

**Concept — Rigid Body Dynamics:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Tangential speed  $v = \omega r = 10 \times 0.5 = 5 \text{ m/s}$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (5) [Go Back to A35](#)



A36.

**Solution**

**Concept — Programming:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $4! = 4 \times 3 \times 2 \times 1 = 24$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to A36](#)

A37.

**Solution**

**Concept — Binary Heap:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A min-heap maintains the smallest key at the root.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to A37](#)

A38.

**Solution**

**Concept — Robot Wrist:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A spherical wrist has intersecting rotational axes and primarily controls tool orientation.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to A38](#)



A39.

**Solution**

**Concept — Stepper Motors:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Total microsteps per revolution =  $200 \times 8 = 1600$ . Angle =  $360/1600 = 0.225$  degrees.

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (0.225) [Go Back to A39](#)

A40.

**Solution**

**Concept — Trajectory Planning:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A trapezoidal profile accelerates, moves at constant velocity, and then decelerates.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to A40](#)

**Part B1 - Electrical Engineering Optional**

B11.

**Solution**

**Concept — Analog Filters:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A low-pass filter passes frequencies below its cutoff and attenuates higher frequencies.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to B11](#)



B12.

**Solution**

**Concept — Operational Amplifiers:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The ideal op-amp has infinite input impedance and very high open-loop gain.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to B12](#)

B13.

**Solution**

**Concept — Schmitt Trigger:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Hysteresis improves noise immunity during switching.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to B13](#)

B14.

**Solution**

**Concept — ADC:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Number of levels =  $2^8 = 256$ .

**Question Type:** NAT; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (256) [Go Back to B14](#)



B15.

**Solution**

**Concept — Microcontrollers:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A microcontroller commonly contains CPU, memory, I/O ports and timers.

**Question Type:** MSQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (ABC) [Go Back to B15](#)

B16.

**Solution**

**Concept — Filters:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $f_c = 1/(2\pi RC) = 1/(2 \times 3.14 \times 1000 \times 0.159 \times 10^{-6})$  is about 1000 Hz.

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (1000) [Go Back to B16](#)

B17.

**Solution**

**Concept — Sampling Theorem:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Nyquist sampling requires  $f_s > 2f_{\max}$ , so  $f_s$  must be greater than 4 kHz.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to B17](#)



B18.

**Solution**

**Concept — Fourier Transform:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Time shift corresponds to multiplication by an exponential phase factor in the frequency domain.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to B18](#)

B19.

**Solution**

**Concept — RMS Value:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $V_{rms} = V_{peak}/\sqrt{2} = 10/1.414 = 7.07 \text{ V}$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (7.07) [Go Back to B19](#)

B110.

**Solution**

**Concept — Feedback Control:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** For negative feedback,  $T = G/(1 + GH)$ .

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to B110](#)



B111.

**Solution**

**Concept — Routh Stability:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The signs change from + to - once, and from - to + once, giving two sign changes.

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (2) [Go Back to B111](#)

B112.

**Solution**

**Concept — Steady-State Error:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A type-1 system has finite velocity error constant  $K_v$  for ramp input.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to B112](#)

B113.

**Solution**

**Concept — Bode Plots:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Each first-order pole contributes -20 dB per decade after its corner frequency.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to B113](#)



B114.

**Solution**

**Concept — PID Control:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Derivative control responds to the rate of change of error and can improve damping.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer: (A)** [Go Back to B114](#)

B115.

**Solution**

**Concept — Z Transform:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Multiplication by  $z^{-1}$  represents a delay of one sampling period.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer: (B)** [Go Back to B115](#)

**Part B2 - Mechanical Engineering Optional**

B21.

**Solution**

**Concept — Stress and Strain:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Normal stress  $\sigma = F/A$ .

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer: (D)** [Go Back to B21](#)



B22.

**Solution**

**Concept — Strain Gauges:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** A strain gauge changes resistance as it is strained.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to B22](#)

B23.

**Solution**

**Concept — Bending Moment:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The maximum moment at midspan is  $PL/4$ .

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to B23](#)

B24.

**Solution**

**Concept — Torsion:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** For circular shafts,  $T/J = \tau/r = G \theta/L$ .

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to B24](#)



B25.

**Solution**

**Concept — Bearings:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Bearings support shafts or moving parts and reduce friction.

**Question Type:** MCQ; **Marks:** 1.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (D) [Go Back to B25](#)

B26.

**Solution**

**Concept — Stress:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $\text{Stress} = 10000 \text{ N} / 100 \text{ mm}^2 = 100 \text{ N/mm}^2 = 100 \text{ MPa}$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (100) [Go Back to B26](#)

B27.

**Solution**

**Concept — Elasticity:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $\text{Lateral strain magnitude} = \nu \times \text{axial strain} = 0.3 \times 0.001 = 0.0003$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (0.0003) [Go Back to B27](#)



B28.

**Solution**

**Concept — Columns:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** For pinned-pinned ends,  $P_{cr} = \pi^2 EI/L^2$ .

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to B28](#)

B29.

**Solution**

**Concept — Vibrations:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:**  $\omega_n = \sqrt{k/m} = \sqrt{200/2} = \sqrt{100} = 10 \text{ rad/s}$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to B29](#)

B210.

**Solution**

**Concept — Gears:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Speed ratio is inversely proportional to teeth. Driven speed = driver speed  $\times 20/60 = \text{one-third}$ .

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

[Go Back to B210](#)



B211.

**Solution**

**Concept — Fatigue:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The S-N curve relates stress amplitude to number of cycles to failure.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to B211](#)

B212.

**Solution**

**Concept — Failure Theories:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Von Mises distortion energy theory is widely used for ductile yielding.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (A) [Go Back to B212](#)

B213.

**Solution**

**Concept — Balancing:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Force =  $m r \omega^2 = 0.2 \times 0.1 \times 100 = 2 \text{ N}$ .

**Question Type:** NAT; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (2) [Go Back to B213](#)



B214.

**Solution**

**Concept — Additive Manufacturing:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** Additive processes create parts by adding material layer by layer from digital models.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (B) [Go Back to B214](#)

B215.

**Solution**

**Concept — Castigliano Theorem:** Identify the relevant concept, formula or rule and apply it to the given data.

**Reasoning:** The derivative of strain energy with respect to a load gives the corresponding deflection.

**Question Type:** MCQ; **Marks:** 2.

**Final Answer:** The correct answer is  $\Rightarrow$

**Answer:** (C) [Go Back to B215](#)



## Answer Key

| Q    | Ans  | Q    | Ans    | Q    | Ans   | Q    | Ans   | Q    | Ans |
|------|------|------|--------|------|-------|------|-------|------|-----|
| GA1  | A    | GA2  | B      | GA3  | 10000 | GA4  | C     | GA5  | 12  |
| GA6  | D    | GA7  | 20     | GA8  | A     | GA9  | B     | GA10 | 0.4 |
| A1   | -2   | A2   | A      | A3   | 12    | A4   | 9     | A5   | B   |
| A6   | 0.5  | A7   | C      | A8   | 2     | A9   | 10    | A10  | D   |
| A11  | A    | A12  | 3      | A13  | B     | A14  | ABD   | A15  | 1.8 |
| A16  | C    | A17  | 10     | A18  | 4     | A19  | D     | A20  | A   |
| A21  | B    | A22  | C      | A23  | D     | A24  | 6     | A25  | A   |
| A26  | B    | A27  | ABD    | A28  | C     | A29  | D     | A30  | A   |
| A31  | 400  | A32  | ABD    | A33  | B     | A34  | C     | A35  | 5   |
| A36  | 24   | A37  | D      | A38  | A     | A39  | 0.225 | A40  | B   |
| B11  | A    | B12  | B      | B13  | C     | B14  | 256   | B15  | ABC |
| B16  | 1000 | B17  | D      | B18  | A     | B19  | 7.07  | B110 | B   |
| B111 | 2    | B112 | C      | B113 | D     | B114 | A     | B115 | B   |
| B21  | D    | B22  | C      | B23  | B     | B24  | A     | B25  | D   |
| B26  | 100  | B27  | 0.0003 | B28  | C     | B29  | 10    | B210 | B   |
| B211 | A    | B212 | A      | B213 | 2     | B214 | B     | B215 | C   |

