

**ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2025
EXAMINATION CATEGORY: TECHNICAL**

PAPER III: SUBJECT SPECIALISATION PAPER FOR MECHATRONICS ENGINEERING

Date	:	October 11, 2025
Total Marks	:	100
Writing Time	:	150 minutes (2.5 hours)
Reading Time	:	15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
 Part II - 5 Short Answer Questions
 All questions under SECTION A are **COMPULSORY**.
4. **SECTION B** consists of **THREE** Case Studies. Attempt any **TWO** case study
5. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
6. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
7. Begin each Section and Part on a fresh page of the Answer Booklet.
8. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
9. Use of any other paper including paper for rough work is not permitted.
10. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
11. This paper has **8 printed pages**, including this instruction page.

GOOD LUCK

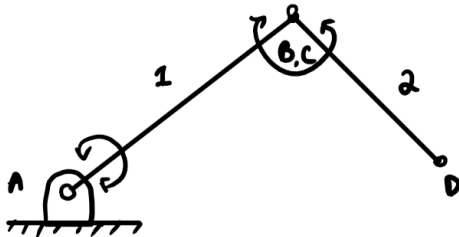
SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. _____ robot allows a programmer to teach robot paths and positions.
 - a) Self monitored stop
 - b) Speed and separation monitoring
 - c) Power and force limiting
 - d) Hand guiding
2. _____ is the simplest method of collaborative robots and is used in applications when human interaction with robot is less.
 - a) Self monitored stop
 - b) Speed and separation monitoring
 - c) Power and force limiting
 - d) Hand guiding
3. BAXTER is which type of robot?
 - a) Humanoid robot
 - b) Industrial robot
 - c) Hospital robot
 - d) Workspace robot
4. Cobots function is to allow computer control of motion by _____.
 - a) Motors
 - b) Human worker
 - c) Payload
 - d) Power
5. Which generation robots are repeating, non-servo, pick-and-place, or point-to-point kind?
 - a) First generation
 - b) Second generation
 - c) Third generation
 - d) Fourth generation
6. Which generation robots have sensing devices to exhibit path-control capabilities but lack artificial intelligence?
 - a) First generation
 - b) Second generation
 - c) Third generation
 - d) Fourth generation
7. Which generation robots have sensing devices to exhibit path-control capabilities but lack artificial intelligence?
 - a) First generation
 - b) Second generation
 - c) Third generation
 - d) Fourth generation

8. Which generation robots are acquired with artificial intelligence, self-learning, and conclusion-drawing capabilities by past experiences?
- First generation
 - Second generation
 - Third generation
 - Fourth generation
9. _____ is a machine that has functions similar to human upper limbs, and moves the objects spatially.
- Manipulator
 - Playback Robot
 - Intelligent Robot
 - Smart Device
10. _____ is a robot that can determine its own behavior and conduct through its functions of sense and recognition.
- Manipulator
 - Playback Robot
 - Intelligent Robot
 - Smart Device
11. _____ is a manipulator that is able to perform an operation by reading off the memorized information for an operating sequence, which is learned beforehand.
- Manipulator
 - Playback Robot
 - Intelligent Robot
 - Smart Device
12. How many Degrees of freedom (DOF) does a prismatic and revolute joint have respectively?
- 1, 1
 - 2, 1
 - 1, 2
 - 2, 2
13. How many degrees of freedom does the following figure have?



- 2
- 3
- 6
- 9

14. What is Artificial Intelligence?
- a) Artificial Intelligence is a field that aims to make humans more intelligent
 - b) Artificial Intelligence is a field that aims to improve the security
 - c) Artificial Intelligence is a field that aims to develop intelligent machines
 - d) Artificial Intelligence is a field that aims to mine the data
15. Which type of sensors are used for tracking the humanoid's body and joints movement, its orientation, position and speed?
- a) mpu6050
 - b) ECG monitoring sensor
 - c) Proprioceptive
 - d) Exteroceptive
16. Which among the following is a home robot?
- a) Vyommitra
 - b) Zenbo
 - c) Athlete
 - d) Valkyrie
17. What is the workspace of SCARA (Selective Compliance Assembly Robot Arm)?
- a) Cylindrical workspace
 - b) Cuboidal workspace
 - c) Spherical workspace
 - d) No workspace
18. The workspace of an RPP manipulator is _____
- a) Cylindrical workspace
 - b) Cuboidal workspace
 - c) Spherical workspace
 - d) No workspace
19. The workspace of a PPP manipulator is _____
- a) Cylindrical workspace
 - b) Cuboidal workspace
 - c) Spherical workspace
 - d) No workspace
20. How many links does a kinematically redundant manipulator have?
- a) Only one
 - b) Three
 - c) Five
 - d) More than Six
21. Washing machine is a Robot. True or false?
- a) True
 - b) False

22. In how many categories process of Artificial Intelligence is categorized?
- a) categorized into 5 categories
 - b) processes are categorized based on the input provided
 - c) categorized into 3 categories
 - d) process is not categorized
23. How many degrees of freedom does an object in 2D space have?
- a) 1
 - b) 2
 - c) 3
 - d) 6
24. How many degrees of freedom does a rigid body free in 3D space have?
- a) 3
 - b) 6
 - c) 9
 - d) 12
25. The _____ of a manipulator is the total volume swept out by the end-effector as the manipulator executes all possible motions.
- a) Workspace
 - b) Work envelope
 - c) Work load
 - d) Workplace
26. Collaborative robots are easily integrated into existing production environment. With _____ articulation points.
- a) 4
 - b) 5
 - c) 6
 - d) 3
27. The collaborative robot arms are designed to mimic the range of motion of a _____
- a) Network
 - b) Machine arm
 - c) Device
 - d) Human arm
28. In co – robot co represents?
- a) Coordinative
 - b) Collaborative
 - c) Computer
 - d) Control

29. The cobots assured human safety by having no internal source of _____
- a) General Motors
 - b) Safe equipment
 - c) Industrial material
 - d) Motive power
30. Which type of collaborative robot installation also uses traditional industrial robots?
- a) Self monitored stop
 - b) Speed and separation monitoring
 - c) Power and force limiting
 - d) Hand guiding

PART II – Short Answer Questions [20 marks]

This part has 5 Short Answer Questions. Answer ALL the questions. Mark for each sub-question is indicated in the brackets.

- 1. What is robotic engineering? **(2.5 marks)**
- 2. What are core components of robots and explain each component. **(5 marks)**
- 3. What are the types of robots and state their purpose **(5 marks)**
- 4. List the applications of Robotics and state their applications. **(5 marks)**
- 5. List five benefits of robot use in industry. **(2.5 Marks)**

SECTION B: CASE STUDY [50 marks]

This section consists of THREE Case study. ATTEMPT ANY TWO CASES. Each case study carries 25 marks.

Select either CASE I OR CASE II from this section and answer the question. Each case study carries 50 marks.

CASE I

Human involvement remains crucial in many manufacturing settings. For instance, current collaborative robots must often reduce speed or halt when people enter their workspace, causing interruptions in production. Baxter, a dual-armed collaborative robot from Rethink, has seen underwhelming sales as it primarily handles straightforward tasks like moving materials, picking parts, and packing or unpacking boxes. Its operational speed is limited by safety protocols. Despite technological progress, robots still fall short of replicating the delicate motor skills humans use to manipulate materials and small components. Handling soft or flexible items such as fabric or bundles of wires remains a significant challenge for robots.

While robots excel at performing repetitive, well-defined tasks with consistency, they struggle with adaptability. Mercedes-Benz had to reduce its reliance on robots in assembly lines because the high degree of customization demanded by customers requires flexibility and dexterity that only humans can provide. Today's Mercedes buyers expect to personalize their vehicles extensively, selecting from options like carbon-fiber trim, four varieties of tire valve caps, and heated or cooled cup holders across 30 different models. Robots cannot manage the vast array of customization options available.

Mercedes has discovered that centering production around skilled human teams allows them to reconfigure assembly lines over a weekend, whereas reprogramming robots and adjusting workflows would take weeks, causing costly downtime. Although robots will continue to be part of Mercedes' manufacturing environment, they will be smaller, more adaptable, and work alongside human operators.

As robotic technology becomes more prevalent, the nature of human roles in manufacturing will evolve toward higher-level, more complex responsibilities. Workers will increasingly oversee and manage robotic systems, enhancing productivity and quality.

1. Why have robots caught on in manufacturing? What knowledge do they require?
2. Can robots replace human workers in manufacturing? Explain your answer
3. If you are considering introducing robots in your manufacturing plant, what management, organization and technology issues would you need to address

CASE II

Robots are becoming easier to use, no longer requiring software engineers for programming. Many can learn tasks simply by guiding their arms and pressing a button.

At Renault's Cleon plant in France, Universal Robots from Denmark fasten screws in hard-to-reach engine parts. These robots have over 50-inch reach, six rotating joints, and verify correct assembly. Weighing about 64 pounds, they're portable and designed to work safely alongside humans, using sensors to avoid collisions.

This new robot generation is also entering other industries. ABB Ltd in Switzerland and others use them for assembling consumer electronics, while JCB Laboratories in Kansas employs robots to fill and cap syringes, working five to six times faster than humans.

Advanced robotics are transforming factories and global competition. By 2025, robots are expected to perform 25% of manufacturing tasks worldwide, up from 10%, with some sectors exceeding 40%. This could boost worker productivity by 30% and shift manufacturing leadership.

However, robots won't fully replace humans on production lines, as they still lack flexibility, precision, and judgment.

1. Why have robots caught on in manufacturing? What knowledge do they require?
2. Can robots replace human workers in manufacturing? Explain your answer
3. If you are considering introducing robots in your manufacturing plant, what management, organization and technology issues would you need to address?

TASHI DELEK