

## **SIDI PhD Written Test – Syllabus & Format**

### **The written test consists of two parts (A & B)**

#### **Part-A will have questions related to the following topics:**

1. Visualization and spatial ability: Pictorial and diagrammatic questions to test the understanding of transformation and/or manipulation of 2D shapes and 3D objects and their spatial relationships.
2. Environmental and social awareness: General awareness of environmental factors (such as climate, population, water, vegetation, pollution, weather, natural resources) and their implications on the design of products, images, infrastructure and environment. Awareness of design terminologies, social and cultural connection with design, history of the designed artefact, and socially responsible and environmentally sustainable design responses. History of art, sculpture and literature.
3. Analytical and logical reasoning: Ability to analyse given information logically and select the most appropriate solutions; ability to weigh opinions, arguments or solutions against appropriate criteria; ability to use logic and structured thinking to deduce from a short passage, which of a number of statements is the most accurate response to a posed question.
4. Language and creativity: Ability to understand passages in commonly used English language; ability to think creatively in terms of alternatives; ability to distinguish innovative options and think out-of-the-box.
5. Design thinking and problem solving: Ability to understand the context, the users and the constraints and select the most appropriate solution for a given design problem.
6. Observation and design sensitivity: Ability to detect concealed properties in day-to-day life and think critically about them. Ability to discern subtle differences in visual properties and aesthetic outcomes.
7. Drawing: Ability to draw products, people or scenes in proportion with good line quality, composition, proportion, perspective, and shading.
8. Creativity: Ability to think out-of-the-box and come-up with unique as well as diverse solutions.
9. Communication skills: Ability to communicate concepts and ideas clearly with the help of text and visuals.
10. Problem identification skills: Ability to understand the user and the context, knowledge of properties of materials and their appropriate use in design.

**Part-B will have questions related to the following topics:**

1. Robotics and automation
  - a. Basic concepts: Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots.
  - b. Power sources and sensors: Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.
  - c. Manipulators, actuators and grippers: Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – u various types of grippers – design considerations.
  - d. Kinematics and path planning: Solution of inverse kinematics problem – multiple solution Jacobian work envelope – hill climbing techniques – robot programming languages.
2. Medical devices – Implantable devices, minimally invasive surgery and robotic assisted surgery
3. Biosensors, Surface functionalization in biosensors, Optical Colorimetry and fluorescence, Electrochemical: Amperometric, Impedimetric and Voltametric, Nanobiosensors, Biofunctionalization of nanomaterials, Nanomaterials for signal amplification and transducer fabrication, Microfluidics (Lab on Chip ) integrated point of care biosensors.
4. Wearable Technologies - Fabrication and Sensor development (Solid State Devices) - Basics of semiconductor physics: intrinsic, extrinsic, carrier transport, mobility, Nanomaterials,
  - a. Basics of Electrical, Electronics, and Instrumentation – Ohm's Law, Kirchhoff's Law, Thevenin, Norton, Diode, Transistors, Amplifiers, OP-AMP, Transducers.
  - b. Data collection and Data processing – Basics of signals and systems, Fourier Series, Fourier Transforms, Sampling Theorem.
  - c. Image Analysis – Basics of Image Processing: Image pre-processing, segmentation, morphological operations, feature extraction, classification
5. Laser Characteristics: Coherence, directionality. power, monochromatic, intensity, and Phase; Laser Properties & Processes- spontaneous emission, stimulated emission, and population inversion; Laser types solid state lasers, gas lasers, diode lasers, and pulsed lasers, and continuous lasers. Photonics: Absorption, emission and reflection, Si detectors, photomultiplier tubes.
6. Bio-inspired Design,
  - a. Mechanical design – hierarchical construction, Bio-inspired impact resistance, self-healing. Materials and surfaces - Muscles and artificial muscles, lotus effect, gecko adhesion, desert beetle, pitcher plants, bio-fouling, coatings. Silver ant and heat dissipation, Biological and bio-inspired sensors;
  - b. Bio-optics – structural colors, compound eyes, antireflection, stealth, imaging;
7. Additive manufacturing technologies and its applications: Fused Deposition Modeling (FDM), Selective Laser Sintering(SLS), Stereolithography (SLA), Selection Laser Melting (SLM), Jetting, 3D Printing, Laser Engineering Net Shaping (LENS), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM) Capabilities, materials, costs, advantages and limitations of different systems. AM applications in Battery thermal

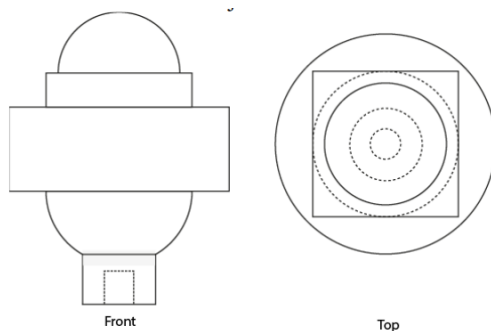
management, Desalination, Defense, Bio-reactors, Aerospace, Automobile, Medical implants

8. CAD Modelling for 3D printing: 3D Scanning and digitization, data handling & reduction Methods, AM Software: data formats and standardization, slicing algorithms: - uniform flat layer slicing, adaptive slicing, Process-path generation: Process-path algorithms, rasterization, part Orientation and support generation.
9. Design of thermal systems: Conduction, convection and Radiation- design of heat exchangers- optimization of multicomponent thermal energy system-cogeneration and waste heat recovery- triply periodic minimal surface- Gyroid Structures-Lattice structures with AM.
10. Quality control and reliability: Defects in FDM, SLS and SLM, Critical process parameters: geometry, temperature, composition, phase transformation, Numerical and experimental evaluation: roles of process parameter combination, process optimization.

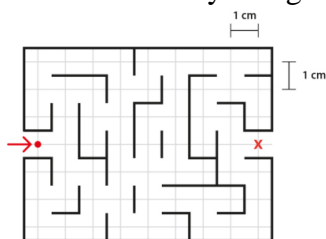
## Sample Questions

### Part A

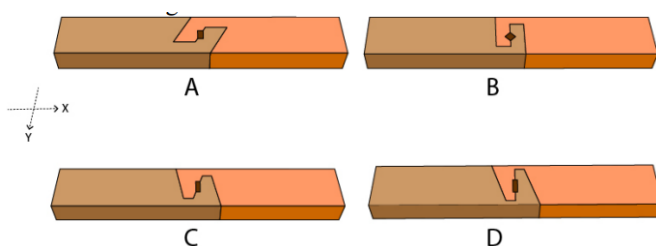
1. Two views of a solid object are shown. Count the number of surfaces.



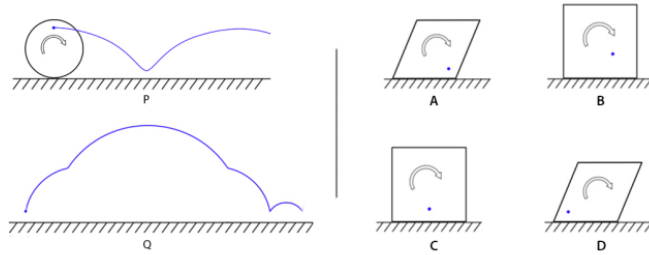
2. What is the shortest distance (in cm) for the red dot to reach the position x? The dot can travel only along the grid lines shown.



3. Given options show wooden joints, each made of 2 wooden blocks of different colours with a wooden pin at the centre. All joints can be released along the Z axis. Which of the joints can be released along the Y axis?



4. Figure P shows how a point on a circle traces a path when it is rolled on the ground. The point in which of the polygons shown in the options creates the path in Figure Q?



### Part B

- What are the different configurations (robot structure) that are commonly used for industrial robots? With free hand sketches show the workspace of different robot configurations.
- With respect to an industrial robotic arm explain the following in brief. Use a normal distribution curve for explanations.
  - Spatial resolution
  - Accuracy
  - Repeatability
- With a neat sketch explain the working of a tactile sensor.