BCS THE CHARTERED INSTITUTE FOR IT

BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 5 Diploma in IT

SMART SYSTEMS

SAMPLE PAPER AND ANSWER POINTERS

Answer **any** FOUR questions out of SIX. All questions carry equal marks.
Time: TWO hours

The marks given in brackets are **indicative** of the weight given to each part of the question.

Calculators are **NOT** allowed in this examination.

Section A
Answer Section A questions in Answer Book A

A1.

Smart Systems and Artificial Intelligence (AI) are terms that are widely used.

a)   Define Smart Systems.

(5 marks)

b)   AI attempts to mimic and model human Intelligence. Outline **TWO** approaches that can be used to achieve this and discuss the advantages **AND** disadvantages of **EACH** approach.

(10 marks)

c)   Briefly discuss the difference between deep and shallow learning with regards to Artificial Neural Networks (ANN), and Deep Neural Networks (DNN), in order to learn effective representational patterns of data for the development of Smart Systems.

(10 marks)

A1. Answer Pointer

[Syllabus coverage 1. Core Concepts
1.1 Smart Systems & their background
1.2 Principals & fundamentals of AI]

a).   *Marks awarded for:*

Basic: A brief definition of Smart Systems that might include that they are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy.

Stronger: Building on the basic answer that might include sensing, actuation, control.

Exemplary: A thorough definition building on the stronger answer that will include that they involve decision-making using available data in a predictive or adaptive manner (smart actions).

(5 marks)

b).   *Basic: The identification of the two approaches.*

Stronger: Building on the basic answer and to include more details for example that they symbolic logical systems attempt to model the logic humans follow and that the neuron-based systems which model how the brain works with one or two advantages and disadvantages.

Exemplary: A thorough explanation building on the stronger answer that will include relevant examples in the discussion.

(10 marks)

c).   ***Basic:*** *A brief definition of the differences between the two.*

Stronger: *Building on the basic answer that includes that deep neural network is an artificial neural network with multiple hidden layers of units between the input and output layers. Shallow learning where decision trees are sufficient for the performance.*

Exemplary: *Thorough explanations and discussion building on the stronger answer with valid examples.*

(10 marks)

A2.

Pervasive computing is one the main realisation enablers of smart systems and the Internet of Things (IoT).

a)   Explain what pervasive (ubiquitous) computing is and how it is related to smart systems and in particular IoT.

(10 marks)

b)   Identify and give a brief explanation of **THREE** enabling technologies (other than pervasive computing) that have an impact on IoT development and implementation.

(15 marks)

A2. Answer Pointer

[Syllabus coverage 1. Core Concepts
1.3 Pervasive Computing
1.5 Internet of Things]

a).   **Basic:** *A brief explanation of pervasive computing and IoT (or smart systems in general) and the fact that pervasive computing has enabled and facilitated the implementation of smart systems and the IoT concept.*

Stronger: *Building on the basic answer that might include some of the following:*

- *History of pervasive computing and its core concepts*
- *Goals of pervasive computing*
- *Definition of Smartness in smart systems and its realisation with pervasive computing*

Exemplary: *Thorough explanations building on the stronger answer that will include relevant **examples** in the discussion.*

(10 marks)

b).   **Basic:** *The candidate identifies at least three from the following list with little explanation:*

- *Cloud Computing*
- *Mobile Networks*
- *Sensor Networks*
- *Tracking (RFID)*
- *GPS*
- *Block-chain*

Stronger: *Building on the basic answer with the inclusion of a good explanation for each technology.*

Exemplary: *A thorough explanation that builds on the stronger answer.*

(15 marks)

A3.

Applications of AI in business and industry, for example Data Mining, are increasingly being used.

a)   Using **THREE** relevant examples to illustrate your answers, explain the differences between data mining and data analytics.

(15 marks)

b)   Machine Learning is an enabling technology used in the development of Smart Systems. Define Machine Learning and explain its purpose.

(10 marks)

A3. Answer Pointer

[Syllabus coverage 1. Core Concepts
1.6 Big Data: Data Analytics & Data Mining
2. Enabling Technologies
2.6 AI & Machine Learning]

a)   *Basic: The candidate gives a brief definition and explanation of the difference between the two using only two relevant examples from the list below:*

Data Mining: the process of extracting data:

- *Discovering patterns in a large set of data*
- *Uses machine learning, statistics and database systems*
- *Purpose - to find patterns*
- *Output - data patterns*
- *Finds relationships between different entities*

Data Analytics: the superset of data mining:

- *Uses tools to analyse data in making a business decision*
- *Statistical and mathematical data analysis that clusters, segments, scores and predicts what scenarios are most likely to happen.*
- *Purpose – to manipulate data for a particular outcome*
- *Outcome – develop models and results*
- *Finds trends in customer preferences etc.*

Stronger: Building on the basic answer with the inclusion of a good explanation and the inclusion of at least three relevant examples.

Exemplary: An excellent, thorough explanation of the differences that will include relevant, valid examples.

(15 marks)

b)   *Basic: The candidate gives a brief definition and brief explanation of the purpose of Machine Learning.*

Machine Learning: *Is a method of designing a sequence of actions to solve a problem. Machine learning can be supervised, unsupervised or reinforced.*

Stronger: *Building on the basic answer, the candidate might include at least two from the following:*

- *that it automatically optimises through experience and with limited or no human intervention*
- *it investigates how computers can learn (or improve their performance) based on data*
- *it enables computer programs to automatically learn to recognise complex patterns and make intelligent decisions based on data.*
- *Supervised: learning for classification and prediction problems – model relationships and dependencies between the target prediction output and the input features*
- *Unsupervised: the computer is trained with unlabelled data – clustering algorithms and Association rule learning algorithms*
- *Reinforced: reinforcement learning using observations gathered from the interaction with the environment. (it is directly related to the branch of AI).*

Exemplary: *The candidate gives a good definition and a thorough explanation of the purpose of Machine Learning, including most of the above in the explanation.*

(10 marks)

Section B
Answer Section B questions in Answer Book B

B4.

Cyber Physical Systems (CPS) play an important role in the development and implementation of Smart Systems.

a)   Define Cyber Physical Systems and explain their purpose.

(10 marks)

b)   Identify **THREE** of the main challenges with Cyber Physical Systems, using relevant examples to illustrate your answers.

(15 marks)

B4. Answer Pointer

[Syllabus coverage 5. Cyber physical systems security
5.1 Operation Technologies vs IT security
5.2 Challenges of OT security
5.3 CPS risk management]

a)   *Basic: The candidate gives a brief definition in that CPSs enable a Smart and Connected World*

Stronger: Building on the basic answer, the candidate might include that they provide responsive, precise, reliable and efficient systems for smart devices and systems and make reference to at least two from the following:

They integrate:

- *Sensing*
- *Computation*
- *Control and networking into physical objects and infrastructure*
- *Connecting them to the Internet and to each other*
- *To control a physical process and, through feedback, adapt itself to new conditions, in real time.*

Exemplary: The candidate builds on the stronger answer and provides a thorough definition and a thorough explanation for their purpose that includes most of the above.

b)   *Basic: The candidate should identify at least two of the main challenges with little or no definition and examples from Security, privacy, risk, resilience and safety requirements.*

Stronger: *Building on the basic answer, discussing three relevant examples and candidates might include that the challenges are dependent upon the particular application. Examples such as police or military applications might be discussed as they have high safety, security and resilience requirements based on their goals. Fitness tracking applications tend to have low requirements for risk-related CPS properties, but have significant privacy risks. CPSs have to be protected from malicious attacks.*

Exemplary: *Thorough identification of challenges supported with relevant examples.*

(15 marks)

B5.

Smart Systems rely on several enabling technologies for their development and implementation and use.

a) Cloud technology is an essential enabling technology for Smart Systems. Define cloud technology and its purpose.

(9 marks)

b) Discuss the advantages **AND** disadvantages of cloud technology when used in connection with Smart Systems, giving examples

(16 marks)

B5. Answer Pointer

[Syllabus coverage 2. Enabling Technologies
2.3 Cloud Computing
Syllabus coverage 4. Impacts & Challenges
4.1 Ethical considerations and social impacts
4.3 Privacy concerns
4.4 Security concerns
4.6 Legal]

5a) **Basic:** A brief definition with little discussion of purpose that might include some of the following:

- Cloud computing facilitates shared computing resources via servers over the Internet and provides on-demand individual access to global computer system resources and services (including storage of data), anytime, anywhere.

Stronger: Building on the basic answer that might include some of the following and/or other relevant information:

- There are 3 main types of cloud, public cloud services, private clouds and hybrid clouds. Types of cloud services include, Infrastructure as a service (IaaS), Platform as a service (PaaS), and Software as a service (SaaS).

Exemplary: A thorough definition with a thorough explanation of its purpose building on the stronger answer that will include relevant examples in the discussion.

5b) **Basic:** The candidate identifies one or two advantages/disadvantages with little or no discussion.

Advantages:

- Improved collaboration
- Improved performance and speed
- Business continuity
- Consistent updates
- Increased storage capacity
- Instant software updates

Disadvantages:

- Ethical issues
- Security
- Privacy and confidentiality
- Storage of data in multiple physical locations across many global areas – owned/delivered by different organisations
- Shifting of control from users to 3rd parties due to outsourcing and off shoring
- Geo-political issues – governed by the laws of the country where the server is physically located.

Stronger: Building on the basic answer identifying at least three advantages/disadvantages and some relevant discussion.

Exemplary: A thorough discussion building on the stronger answer that will include a number of relevant advantages/disadvantages.

B6.

The domain of Smart Systems is becoming increasingly part of our daily lives.

6a) Identify and discuss **THREE** examples of Smart Systems used in real life situations.

(15 marks)

6b) Using **TWO** of the examples from above, identify and discuss any risks and ethical implications that might occur with their use.

(10 marks)

B6. Answer Pointer

[Syllabus coverage 3. Applications
3.1 Smart Homes
3.2 Smart Appliances
3.3 Smart Things
3.4 Health care
4. Impacts & Challenges
4.1 Ethical considerations and social impacts
4.3 Privacy concerns
4.4 Security concerns
4.6 Legal]

6a) **Basic:** Identifying three examples ranging from smart phones to smart city devices or any from the following list or other valid smart systems with little or no discussion.

- Transportation and energy - driver less cars
- Smart cities and systems
- Systems used in healthcare and medicine – personalised medical devices etc
- Environmental systems
- Economical
- Societal

Stronger: Building on the basic answer with good discussion of the examples.

Exemplary: A thorough discussion building on the stronger answer.

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6b) **Basic:** Identifying two relevant examples with little discussion of any risks that may not include any ethical implications.

Stronger: Building on the basic answer with a good discussion of both the risks and ethical implications for their use with relevant examples. Discussion demonstrates an understanding of ethics with possible examples of security/legal issues, privacy, and impact on people, society, and the environment.

Exemplary: A thorough discussion building on the stronger answer that will include relevant examples.

END OF EXAMINATION