L-1/T-2/CSE  
Date: 12/03/2018

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA


Sub: CHEM 113 (Chemistry I)

Full Marks: 210  
Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - A

There are FOUR questions in this section. Answer any THREE.

1. (a) Schrödinger equation can be represented in a simpler form as $H \Psi = E \Psi$, where $E$ is the energy and $\Psi$ is called a wave function. What information you can get from the equation about an electron in an atom? (6)

(b) Justify the statement – 'The probability of finding two electrons with the same four quantum numbers in an atom is zero.' (10)

(c) Show the change of potential energy of the system when two atoms are getting closer to form a covalent bond. How the energy diagram can be used for the calculation of bond length and bond dissociation energy? (10)

(d) The He$^+$ ion contains only one electron and is therefore hydrogen like ion. Calculate the wavelength, increasing order, of the first four transitions in the Balmer series of the He$^+$ ion. Compare these wavelengths with the same transitions in an H atom. Comment on the differences. (The Rydberg constant for He$^+$ $8.72 \times 10^{-18}$ J is and that for H is $2.18 \times 10^{-18}$ J). (9)

2. (a) Draw the trigonal bipyramidal geometry and mark the axial and equational positions. Which position is suitable for the accommodation of a lone pair in the system? Why? (2+4=6)

(b) Draw the geometry of the followings and predict the angles

(i) PO$_4^{2-}$  
(ii) I$_5^-$ (6)

(c) How does VBT apply the concept of hybridization? Illustrate the hybridization process of water. (3+6 = 9)

(d) Calculate the bond order of the following species:

F$_2^2-$, F$_2^-$, F$_2^+$, F$_2^{2+}$

From the calculated values of bond order list the species in order of increasing bond energy and in order of increasing bond length. (9)

Contd ......... P/2
(e) Can you explain the existence of the transient ions like $H_2^+$? How?

3. (a) Define ‘solution’. Explain that the solution process is governed by energy and entropy.
(b) Describe an equation which can be well applied for the determination of heat of solution using the experimental data of solubility. Design the experiment.
(c) Give a molecular interpretation of the positive and negative deviation from ideal behavior from Raoult's law.
(d) A certain soft drink is bottled so that a bottle at 25°C contains $CO_2$ gas at a pressure of 5.0 atm over the liquid. Assuming that the partial pressure of $CO_2$ in the atmosphere is $4 \times 10^{-4}$ atm. Calculate the equilibrium concentrations of $CO_2$ soft drink both before and after the bottle is opened. The Henry's law constant for $CO_2$ in aqueous solution is $3.1 \times 10^{-2}$ mol/L atom at 25°C. Can you relate the 'flat' taste of the drink with concentration in case of the drink being open for a while?

4. (a) Draw the phase diagram of solvent solute system and show that the boiling point elevation due to the addition of non-electrolyte and non-volatile solute is proportional to the molality of the solute.
(b) Sea water contains dissolved salts at a total concentration of about 1.13 mol/L. Draw a desalination diagram for drinking water from sea water.
(c) The freezing point depression measurement of benzoic acid in acetone yields a molar mass of 122 g; the same measurement in benzene gives a value of 244 g. Account for this discrepancy.
(d) A commercial bleach solution contains 3.62 mass% NaOCl in water. Calculate (i) mole fraction (ii) molality of NaOCl in the solution.
(e) A solution of 0.5 g of unknown nonvolatile, non-electrolyte solute is added to 100 mL of water and then placed across a semipermeable membrane from a volume of pure water. When the system reaches equilibrium, the solution compartment is 5.6 cm above the solvent compartment. Assuming that density of solution is 1.0 g/mL. Calculate the molecular mass of the unknown.

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SECTION – B

There are FOUR questions in this section. Answer any THREE.

5. (a) What is the length scale of nanomaterials? Why the length scale of nanosubstances is fascinating in material science? (7)

   (b) Draw a graph showing the approximate percentage of surface atoms as a function of nanocrystal size and explain that surface energy of nanomaterial increases with decrease in size. (7)

   (c) How surface curvature of nanostructure can be used to control the solubility of materials? (7)

   (d) Explain the fact that the color of gold nanoparticle can be tuned by controlling aspect ratio of size. (7)

   (e) How cancer cell can be diagnosed by nanomaterials? What are the health hazards associate with nanomaterials. (7)

6. (a) Why polymers are often insulating? Draw energy level diagrams of metal, semiconductor and insulator. Indicate the band gaps and comment on their conducting behavior. (10)

   (b) How polyacetelene can act as semiconductor? Draw energy level diagram of the hybridized p orbitals of polymer consisting of conjugated double bond and indicate their HOMO, LUMO, valence band and conduction band. (10)

   (c) Describe different types of doping mechanism in conjugated polymers. What is the difference in doping process of conjugated polymers and semiconductors? (10)

   (d) What are the factors that affect the conduction behavior of polymers? (5)

7. (a) Define carbohydrates. Give one example of monosaccharides, Disaccharides and polysaccharides. Draw their structural formula. (10)

   (b) Draw the Fischer projection formula of D-glucose and L-glucose. (5)

   (c) Write down the mechanism of the formation of methyl glycoside from β-D-glucopyranose. Explain which anomeric product of methyl glycoside is more stable than the other one. (10)

Contd ........... P/4
(d) What is mutarotation? Why glucose undergoes mutarotation?  
(e) Prove that glucose is a reducing sugar.

8. (a) What is the definition of soap? Write down the mechanism of saponification of triacylglycerols.  
(b) What is omega-3 fatty acid? Why consumption of omega-3 fatty acid containing oils is good for our health?  
(c) Why natural polymers are more biodegradable than synthetic polymers? What are advantages, disadvantages and applications of thermoplastic starch?  
(d) Draw the primary, secondary, tertiary and quaternary structures of proteins.
SECTION – A

There are FOUR questions in this Section. Answer any THREE.

Symbols used have their usual meaning.

1. (a) Solve: \((6x+1)y^2 \frac{dy}{dx} + 3x^2 + 2y^3 = 0\).  
(b) Solve: \(\frac{dy}{dx} - y \sec x = y^2 \sin x \cos x\).  
(c) Suppose a student carrying a flu virus returns to an isolated college campus of 1000 students. If it is assumed that the rate at which the virus spreads is proportional not only to the number \(x\) of infected students but also to the number of students not infected, determine the number of infected students after 6 days if it is further observed that after 4 days \(x(4) = 50\).

2. (a) Find a differential operator that annihilates the function \(f(x) = 7x^4 + 7 + 3xe^{-3x} + 3 \cos 2x\) and hence solve the differential equation \(y'' + 8y = f(x)\).
(b) An RCL circuit connected in series has a resistance \(R = 180\) ohms, a capacitance \(C = 1/280\) farad, an inductance \(L = 30\) henries, and an applied voltage \(E(t) = 10 \sin t\). Assuming no initial charge in the capacitor, but an initial current 1 ampere at \(t = 0\) when the voltage is first applied. Derive the differential equation of constant coefficients for RCL circuit consider stated conditions. Find the subsequent charge on the capacitor considering the differential equation.
(c) Solve: \(\frac{d^2 y}{dx^2} - y = \cosh x \cos x\).

3. (a) Reduce the Cauchy-Euler equations to constant coefficients \(x \frac{d^2 y}{dx^2} + 10 \frac{dy}{dx} + 8y = x\). Hence, solve by a suitable method.
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(b) Solve: \( \frac{d^2}{dx^2} x - 3x \frac{dy}{dx} + 5y = x^2 \sin(nx) \). \( 13\frac{2}{3} \)

(c) Solve: \( y \frac{d^2}{dx^2} y - \left( \frac{dy}{dx} \right)^2 = y^2 \ln y \). \( 15 \)

4. (a) Solve: \( (y - zx)p + (x + yz)q = x^2 + y^2 \), where \( p = \frac{\partial z}{\partial x}, q = \frac{\partial z}{\partial y} \). \( 18 \)

(b) Find the complete, singular and general integrals of \( (p^2 + q^2)y = qz \). \( 13\frac{2}{3} \)

(c) Find the integral surface of the linear partial differential equation \( 2y(z - 3)p + (2x - z)q = y(2x - 3) \), through the circle \( z = 0, x^2 + y^2 = 2x \). \( 15 \)

SECTION - B

There are FOUR questions in this Section. Answer any THREE.

5. (a) Solve the following partial differential equations

(i) \( (D^2 - DD' - 2D')z = (y - 1)e^z \) \( 10 \)

(ii) \( (D^2 - DD' + D' - 1)z = \cos(x + 2y) + e^x + xy + 1 \) \( 10 \)

(iii) \( (x^2 D^2 - y^2 D' + xD - yD')z = \ln x \) \( 10 \)

(b) Solve the following boundary value problem

\[ \frac{\partial U}{\partial t} = 3 \frac{\partial^2 U}{\partial x^2}, \quad U(0,t) = 0, U(2,t) = 0, U(x,0) = x \quad \text{where} \quad 0 < x < 2, t > 0 \]

Also give the interpretation of the solution. \( 16\frac{2}{3} \)

6. (a) Prove that the vectors \( A = 3i + j - 2k, \quad B = -i + 3j + 4k, \quad C = 4i - 2j - 6k \) can form the sides of a triangle. Find the lengths of the medians of the triangle. \( 20\frac{2}{3} \)

(b) Let the vectors are \( a = i - 3j + 2k \) and \( b = 2i - 4j - k \). Find the vector component of \( a \) in the directions of \( b \) and perpendicular to \( b \). \( 13 \)

(c) Prove that \( \nabla \times (\nabla \times A) = \nabla (\nabla \cdot A) - \nabla^2 A \). \( 13 \)

Contd ............. P/3
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7. (a) In what direction from the point (2, 1, -1) is the directional derivative of \( \phi = x^2yz^3 \) maximum? What is the maximum value of the directional derivative? 

(b) If \( \mathbf{A} = (2y + 3)\mathbf{i} + xz\mathbf{j} + (yz - x)\mathbf{k} \) evaluate \( \int_C \mathbf{A} \cdot d\mathbf{r} \) along the straight lines from (0, 0, 0) to (1, 0, 0) then to (1, 1, 0) then to (2, 1, 1).

(c) Use line integral to find the area of the region enclosed by the asteroid \( x = a \cos^3 \varphi, \ y = a \sin^3 \varphi \ (0 \leq \varphi \leq 2\pi) \).

8. (a) Evaluate \( \iint_S \mathbf{A} \cdot d\mathbf{S} \), where \( \mathbf{A} = 18z\mathbf{i} - 12\mathbf{j} + 3y\mathbf{k} \) and \( S \) is that part of the plane \( 2x + 3y + 6z = 12 \), which is located in the first octant.

(b) Use the Divergence Theorem to find the outward flux of the vector field \( \mathbf{F}(x, y, z) = x^3 \mathbf{i} + y^3 \mathbf{j} + z^3 \mathbf{k} \) across the surface of the region that is enclosed by the upper-hemisphere \( z = \sqrt{a^2 - x^2 - y^2} \) and the plane \( z = 0 \).
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2/CSE Date: 24/02/2018

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA


Sub: CSE 103 (Discrete Mathematics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

All symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - A

There are FOUR questions in this Section. Answer any THREE.

1. (a) For a set S of N elements and t conditions where each of the conditions is satisfied by some of the elements of S. Find the number of elements which do not satisfy any of the conditions of t. Provide the validity of your computation.

(b) Find the number of the non-negative integer solutions to the equation

\[ x_1 + x_2 + x_3 + x_4 = 18 \text{ and } x_i \leq 7 \text{ for all } 1 \leq i \leq 4. \]

(c) In how many ways one can arrange the letters CORRESPONDENTS so that

(i) there are exactly two pairs of consecutive identical letters.

(ii) there are at least three pairs of consecutive identical letters.

(use the principle of inclusion and exclusion)

(d) In how many ways can Mr. Rafiq distribute ten distant books to his ten students (one book for each) and then collect and redistribute the books so that each student has the opportunity to read two different books.

2. (a) For A = \{1, 2, 3, 4, 5\}, \( f : A \rightarrow R \) be defined by \( f = \{(1, 10), (2, 13), (3, 16), (4, 19), (5, 22)\} \), Let \( g : Q \rightarrow R \) where \( g(q) = 3q + 7 \) for all \( q \in Q \). Let \( h : R \rightarrow R \) with \( h(r) = 3r + 7 \) for all \( r \in R \), then find,

(i) the restriction of \( g \) (from \( Q \)) to \( A \)

(ii) the extension of \( g \) (from \( Q \)) to \( R \)

(find the computation)

(b) Let \( A = \{1, 2, 3, 4, 5\}, B = \{w, x, y, z\}, A_1 = \{2, 3, 5\} \) and \( A_1 \) be subset of \( A \), \( g : A_1 \rightarrow B \). In how many ways can \( g \) be extended to a function \( f : A \rightarrow B \)?

Contd .......... P/2
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Contd ... Q. No. 3

(c) Consider a function $f : \mathbb{Z} \rightarrow \mathbb{Z}$ where $f(x) = 3x + 1$ for each $x \in \mathbb{Z}$. The range of $f = \{\ldots, -8, -5, -2, 1, 4, 7, \ldots \} \subset \mathbb{Z}$. Find whether $f$ is injective or surjective support your finding.

(d) A chemist who has five assistants is engaged in a research project that calls for nine compounds that must be synthesized. In how many ways can the chemist assign these syntheses to the five assistants so that each is working on at least one syntheses.

(e) During the first six weeks of the final year Mila sends at least one resume each day but no more than 60 resumes in total. Show that there is a period of consecutive days during which she sends out exactly 23 resumes.

3. (a) Ehsan finds three PCs in a cyber shop. He asked a young woman whether the computers had internet connections. She replied, “PC1 is not connected to the internet. Ask the man J; he is knight.” When Ehsan approached J; he told, “PC2 has an internet connection, but PC3 does not have.” Another man K, replied, “If PC2 has an Internet connection, then so does PC1. PC3 is not connected to the Internet.” Which PC has the Internet connection? (Support your logic) (A knight always speaks the truth and a krane always tells lie) The three individuals are krane or knight.

(b) Prove that $(((\neg p \lor q) \rightarrow r) \land r \rightarrow (s \lor t)) \land (\neg s \land \neg u) \land (\neg u \land \rightarrow \neg t)) \rightarrow p$. (prove by contradiction).

(c) Determine the value of each statement if the universe is nonzero integers.

(i) $\exists x \exists y [3x + y = 8] \land (2x - y = 7)]$

(ii) $\forall x \exists y [x \ast y = 2]$

(d) Prove or disprove that for every integer $n$, $4n + 7$ is odd.

4. (a) A warehouse contains 10 motors. Three of them are defective. The inspection of finding defective motor is carried out in two phases. In the first phase the inspector randomly selects and in the second phase, the inspector again randomly selects another motor. Find the probability tree of the two phase inspection. When (i) the part is replaced and (ii) the part is not replaced.

Contd ............ P/3
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Contd … Q. No. 4

(b) For integers n, r with n ≥ r ≥ 1, prove \( \binom{n + 1}{r} = \binom{n}{r} + \binom{n}{r - 1} \) \( \text{(7)} \)

(c) Any subject of size 6 from the set \( S = \{1, 2, 3, \ldots 9\} \) must contain two elements whose sum is 10. Prove it. \( \text{(8)} \)

(d) Give the Bayes' Theorem (Extended version). Ema finds PC supply from three companies. Company A supplies 60% of the keyboard, Company B supplies 30% of the keyboard and the rest is from company C. Ema knows 2% from company A are defective, while 3% from company B and 5% from company C are defective. What is the probability if she randomly selects a PC, that she will find a defective keyboard? What is the probability that the defective keyboard is from company C? \( \text{(3+7=10)} \)

SECTION – B

There are NINE questions in this Section. Answer any SEVEN.

5. (a) Derive the numbers of relations on a set with \( n \) elements that are (i) reflexive, (ii) reflexive and symmetric, and (iii) antisymmetric. \( \text{(9+6)} \)

(b) Define equivalence relation and partition. Give an example of an equivalence relation.

6. (a) Draw the Hasse diagram for the partially ordered set i.e., poset \( (A, \mathcal{R}) \) where \( A \) is the set of all subsets of \( \{1, 2, 3\} \) and \( \mathcal{R} \) is the subset relation on \( A \). Prove that if \( (A, \mathcal{R}) \) is a poset and \( A \) is finite then \( A \) has a minimal element. \( \text{(8+7)} \)

(b) Prove that the Fibonacci numbers follow the pattern odd, odd, even: that is, show that for any positive integer \( m \), \( F_{3m - 2} \) and \( F_{3m - 1} \) are odd and \( F_{3m} \) is even.

7. Use induction to show that the Euclidean algorithm correctly computes the greatest common divisor (GCD) of two positive integers. \( \text{(15)} \)

8. (a) A palindrome is a sequence of characters which reads the same backward as forward. For example: 5, 070 and 9449 are palindromes whereas 132 and 6436 are not. Find a recurrence relation and give initial conditions for the number of strings of decimal digits that are palindromes. \( \text{(7+8)} \)

Contd ……….. P.7/8
(b) Find the recurrence relation satisfied by $R_n$, where $R_n$ is the number of regions that a plane is divided into $n$ lines, if no two of the lines are parallel and no three of the lines go through the same point.

9. Set up a recurrence relation for the number of moves needed to solve the Tower of Nanoi problem with $n$ disks and solve it using (i) the method for solving linear nonhomogeneous recurrence relation with constant coefficients and (ii) generating functions.

10. (a) Define bipartite graphs and chromatic number of a graph. Prove that a simple graph is bipartite if and only if it is possible to assign one of two different colors to each vertex of the graph so that no two adjacent vertices are assigned the same color.

(b) Which of the following graphs are bipartite?

(i) Complete graph with 4 vertices $K_4$,
(ii) Cycle with 4 vertices $C_4$,
(iii) Cycle with 5 vertices $C_5$,
(iv) Wheel graph with 4 vertices $W_5$.

11. What are Euler paths and Hamilton paths? Show that a connected multigraph with at least two vertices has an Euler circuit if and only if all of its vertices have even degree.

12. (a) Define (i) cut vertex (articulation point), (ii) cut edge (bridge), (iii) vertex connectivity, and (iv) edge connectivity of a graph.

(b) Let $G$ be a connected planar simple graph with $e$ edges and $v$ vertices. Let $r$ be the number of regions in a planar representation of $G$. Then prove that $r = e - v + 2$.

13. (a) Prove that height of a full and balanced $m$-ary tree with $l$ leaves is $h = \lfloor \log_m l \rfloor$.

(b) Show the orders in which vertices of the following tree are visited in a i) preorder, ii) inorder, and iii) postorder traversal.
SECTION - A

There are FOUR questions in this Section. Answer any THREE questions including Q. No. 1 as compulsory.

1. (a) Explain with reference to the context any two of the following:

(i) People were attracted to him as bees are attracted to cosmos or dahlia stalks.

(ii) Although they lived in style, they felt always an anxiety in the house.

(iii) With one part of my mind I thought of the British Raj as an unbreakable tyranny, ...  

(iv) ... with another part I thought that the greatest joy in the world would be to drive a 

bayonet into a Buddhist priest’s guts.

(b) Answer any one of the following:

(i) Do you like the character of the police officer in ‘Shooting an Elephant’? Why or why not?

(ii) How do the children play the role of the grown-ups in ‘Fire on the Mountain’? Does it signify anything?

(c) Answer any three of the following:

(i) Why could Guru Nayak not recognize the astrologer?

(ii) How can Paul predict the name of the winning horse?

(iii) What does the fire symbolize for in the story ‘Fire on the Mountain’?

(iv) What underneath message do you get from the story ‘Shooting an Elephant’?

(v) How is the mother-son relationship in the story ‘The Rocking-Horse Winner’?

2. (a) Recast and correct any ten of the following sentences:

(ii) Mr. Amin suffered from the illusion that he was an executive.

(iii) The number of money needed became larger every day.

(iv) Any and all of the logs can be used as firewood.

(v) Hasan looked differently after his return from Europe.

(vi) Where did you see the deer at when you were hunting?
(vii) Tuhin spoke meditatively, frankly, and sincerely.

(viii) Mr. Hamid’s habit of speaking rapidly impressed the visitor.

(ix) Consider how for a moment in the problem at hand the contributing forces are involved.

(x) The car’s hood is insulated.

(xi) The committee are empowered to make a recommendation.

(xii) That picture is highly invaluable.

(b) Give the meanings of and make sentences with any ten of the following words:

Accomplice, accumulate, admonish, brawl, beneficiary, creed, cluttered, coerce, deprecate, discern, disseminate, enervate.

3. (a) Amplify any one of the following:

(i) Only the actions of the just
Smell sweet, and blossom in their dust.
(ii) Let thy secret, unseen acts,
Be such as if the men thou prizest most
Were witnesses around thee.

4. (a) Write a precis of the following passage:

According to Tagore, education is a piece of diamond and culture is the emission of light there from. So, a well-educated man must be cultured too. People should be cultured in appropriate sense and culture should be mould with dice of its own tradition. The term ‘culture’ is very broad. It comprises music, literature, drama and other aspects of fine arts. The true picture of a country is projected in its culture. In the arena of culture, indigenous culture plays a vital role. In the creation and propagation of culture, patronization also plays a vital role.

Since the dawn of civilization, culture has glorious and magnificent history in the realm of life-style and thought. It is spiritual, philosophical and self-sacrificing with no barriers in living and thought. Culture reflects the way of living, eating, talking and learning for enriching people’s creative endeavour towards handicraft, music, dancing, folk-songs and skills of making various types of musical instruments.

We have a distinct culture and tradition of our own. This culture and tradition is rooted in its soul. Our culture echoes the religious belief that we have inherited from our ancestors. The Liberation War in 1971 and the Language Movement in 1952 are the glorious bright sides of our cultural history. As a nation though we are economically poor, its facet has the luster of a meaning of struggle for survival on earth.
According to a UN report, by 2030 two-thirds of the world’s population will be living in cities, the urban population in developing countries will double, and the area covered by cities could triple. This rapid urbanization is increasing pressure on city infrastructure and services, forcing many cities to rethink how they operate. One important way city managers are responding to these challenges, however, is through the development of smart cities. These cities will be dynamic and constantly evolve to keep pace with citizen expectations for high quality services and efficient systems, while ensuring sustainability for the future. Like a living organism, a smart city has a nervous system that comprises a “brain” (the control centre) and “peripheral nerves” (the network and sensors) gathering real-time information about the health and status of the city, its environment and infrastructure. For example, sensors can provide data on the transportation system performance, enabling the brain to manage congestion, smooth demand and safety reduce delays for citizens.

Leading global ICT company, Huawei has helped urban authorities across the world build smart cities. Through leading new ICT, Huawei provides the nervous system to deliver early warnings to potential city issues and drive unified coordination, cross-section collaboration, and intelligent analysis for effective management of city services. More specifically Huawei provides wired and wireless broadband networks that enable ubiquitous broadband coverage supporting high-speed data, video, and voice services. Huawei also delivers an Internet of Things (IoT) platform comprising LiteOS, a secure, lightweight and intelligent OS, and Narrowband IoT (Nb-IoT), a standards-based low power wide area (LPWA) technology developed to enable a wide range of new IoT devices and services.

Building a smart city can not only benefit citizens but also the economy as a whole. Take China’s Dunhuang, as an example. As one of the ancient world’s most important intersections between east and west, Dunhuang is a popular city to visit on the silk Road. In Dunhuang’s desert areas, smart tourism has been developed to improve the quality of services in peak seasons and attract more tourists in off-peak seasons, while promoting city governance and sustainable economic growth. To achieve this, Huawei helped Dunhuang smart Tourism Company (DSTC) build a central cloud centre, linking the service systems of government departments to provide shared information that enables a quick and efficient response to city governance issues, public security, transportation, and city management emergencies.
The project involved the development of a tourist traffic model for desert areas through IoT to improve city management, Silk Road tourism service quality and smart public services. It has received 8 million domestic and overseas visitors every year, scenic spot visitors bearing capabilities increased by 40%, and visitors’ idle time was reduced by 20%.

In fact, smart city development is emerging as a major solution to tackle challenges related to rapid urbanization in cities across the world. Countries such as Saudi Arabia, Kuwait, South Korea, the US, India, UAE, UK, China and Azerbaijan have started building their cities for the future in new spaces. As they do so, they are seen to keep all kinds of digitally driven provisions in mind, so that the people who’d be living in those cities would live a complete digital-smart life. To the government of Bangladesh it has become a big challenge to transform Dhaka as a smart city because currently the city is terribly suffering from various problems such as traffic congestion, water-logging, waste management, air pollution and criminal activities.

Questions:

(i) How can a smart city be compared to a living organism? Explain in at least five sentences.

(ii) What role does ICT play in building a smart city?

(iii) Do you think that there is some kind of advertisement of the ICT company Huawei? How can you be sure of that?

(iv) “Building a smart city can not only benefit citizens but also the economy as a whole” – Explain the statement.

(v) The barriers on the way to make Dhaka a smart city have not been mentioned in the passage. Imagine and make a list of five barriers.

(vi) Give a suitable title of the passage and justify it.

6. (a) Write a note on the importance of a cover letter. How is it different from a resume (CV)?

(b) Suppose you are the manager of an IT firm located at 15 Dilkusha, Motijheel, Dhaka. For your office you need to purchase some goods such as computers, parts of assembly, pens and pencils etc. Write a purchase order to Manager, 11-15 Montague street London, ECI 5 DN detailing the quantity, price, shipment date etc.

(c) Write the phonetic transformation of the words given below: (any five)

Awkward, knave, lunatic, psyche, jovial, individual

Contd ……….. P/5
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7. (a) Suppose some days ago you and your friend visited the Rohingya camps and saw their pitiable conditions. Now write a dialogue between you and your friend on Rohingya Crisis. (10)

(b) Write a short essay on any one of the following: (10)

(i) Use of Robotics in the 21st Century.
(ii) Importance of searching Solar Energy.
(iii) A Funny Event of your life.

(c) What are the components of Back Matter of a formal report? Explain in brief. (10)

8. (a) Change the form of the sentences as directed: (10)

(i) But for your help I could not have done the job. (Complex)
(ii) A business that makes nothing but money is a poor kind of business. (Simple)
(iii) Word-classes in English can be identified morphologically. (Active)
(iv) I want the door to be closed. (Complex)
(v) I liked the job, yet I resigned. (Simple)
(vi) The winter being foggy we cancelled our tour. (Compound)
(vii) In case you don’t attend classes you will lose marks.

(b) What are the main features of an inquiry letter? (5)

(c) Write short notes on any three of the following: (3×5=15)

(i) Qualitative and Quantitative Research
(ii) Importance of stress in English Pronunciation
(iii) Diphthongs
(iv) Plagiarism

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1. (a) What is the signature of Java main method? Briefly describe the significance of each term. (5)

(b) Write Java code to exchange two integer variables using a method named `swap`. The main method will call the `swap` method and the changes inside the `swap` method must be visible to the main method. You also need to write the main method. (7)

(c) Write two different ways to create threads in Java. Which one is better and why? (5)

(d) Write Java code to do the following:

   (i) Declare a static nested class `Inner1` of an outer class `Outer1` and create an object of `Inner1` class inside `NestedDemo` class’s main method.

   (ii) Declare an inner class `Inner2` of an outer class `Outer2` and create an object of `Inner2` class inside `NestedDemo` class’s main method.

(e) Consider the following code segment:

   ```java
   public class Main {
       public static void main(String[] args) {
           int a = minmax("min", 2, 1, 6, 4, 5); // a = 1
           int b = minmax("min", 3, 0, 6); // b = 0
           int c = minmax("max", 1, 2, 6, 5); // c = 6
           int d = minmax("max", 1, 3, 7); // d = 7
       }
   }
   ```

   Write the Java function `minmax`. You can write only one `minmax` function. (10)

Contd .......... P/2
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2. (a) What are the two uses of the super keyword? What do you mean by abstract class? What are the restrictions to classes that extend abstract class? Explain both with short code examples.

(b) What is the problem with the code below? Write two different ways to fix the problem.

```
interface A {
    default void f() {
        System.out.println("A's f");
    }
}

interface B {
    default void f() {
        System.out.println("B's f");
    }
}

class C implements A, B {
}
```

(c) Consider the following code segment:

```
interface i1 {
    default void f1() {
    }
    void f2();
}

interface i2 {
    void f3();
    void f4();
}

abstract class c1 implements i1 {
    abstract void f5();
    final void f6();
}

class c2 extends c1 implements i2 {
    // your code
}
```

Write minimum code in class c2 for successful compilation. You can't define c2 as abstract.

(d) What do you mean by auto-boxing and auto-unboxing? When you shouldn't use them? Explain both with short code examples.

(e) Consider the following class:

```
public class Fruit {
    private String name;
    private int quantity;
}
```

Contd ………. P/3
Suppose there is an ArrayList of Fruit named listFruits. Write necessary Java code so that when Collections.sort(listFruits) is called, the products are sorted by descending order of quantity and if quantity matches then by lexicographic order of their name.

3. (a) Consider the following code segment:

```java
public class College {
    private int ein;
    private int shift;
    private int version;
    private int group;

    public College(int ein, int shift, int version, int group) {
        this.ein = ein;
        this.shift = shift;
        this.version = version;
        this.group = group;
    }

    public static void main(String[] args) {
        College c1 = new College(135790, 1, 1, 0);
        College c2 = new College(135790, 1, 1, 0);
        System.out.println(c1.equals(c2));
        HashMap map = new HashMap();
        map.put(c1, 100);
        System.out.println(map.get(c2));
    }
}
```

The expected output of the above code:

```
true
100
```

Complete the College class to achieve the expected output.

(b) Consider a class named Account with the following information:

- double balance – the balance of the account
- void debit (double amount) – this method subtracts the amount from the balance
- void credit (double amount) – this method adds the amount directly to the balance

The amount provided in the debit and credit method can’t be negative. The balance of the account can’t also be negative.

Write Java code for the following:

(i) A custom exception named InvalidAmountException that triggers when the given amount is negative and shows the message ‘The given amount can’t be negative’.

(ii) A custom exception named InvalidBalanceException that triggers when balance goes negative and shows the message ‘The account balance can’t be less than zero’.

(iii) The Account class to trigger these exceptions when needed.

Contd ......... P/4
CSE 107
Contd ... Q. No. 3

(c) Write Java code that finds the minimum of an array of 500 integers using an array of 5 threads in parallel. You are not allowed to write any more classes or arrays, but you can add normal variables, constructors, and other methods. (10)

```java
class ParallelMin implements Runnable {
    // your code
}
class Main {
    public static void main(String[] args) {
        int[] numbers = new int[500];
        Random random = new Random();
        for (int i = 0; i < numbers.length; i++) {
            numbers[i] = random.nextInt();
        }
        // your code
    }
}
```

(d) Consider the following statement. (5)
Public class Gen<T extends X & Y & Z> {
}

What do you can say about T, X, Y, and Z?

4. (a) Consider the following code segment: (8)

```java
class MyClass {
    String s;
    int i;
    public MyClass(String s, int i) {
        this.s = s;
        this.i = i;
    }
}
```

```java
public class FileDemo {
    public static void main(String args[]) {
        MyClass object1 = new MyClass("James Bond", 7);
        // your code
        MyClass object2;
        // your code
    }
}
```

Write necessary Java code to write `object1` to a file named 'serial' and read the object from the same file and assign it to `object2`.

(b) Write two differences between *ArrayList* and *Vector*. Write three differences between *Hashtable* and *Hashmap*. (10)

Contd ........... P/5
Consider the following information of different football players weekly salary.

<table>
<thead>
<tr>
<th>Name</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lionel Messi</td>
<td>350,000</td>
</tr>
<tr>
<td>Cristiano Ronaldo</td>
<td>365,000</td>
</tr>
<tr>
<td>Neymar</td>
<td>null</td>
</tr>
</tbody>
</table>

Write Java code for the following:

(i) Create an appropriate Hash-based collection to store the above information and then store the above three information.

(ii) Increase Lionel Messi's balance by 100,000.

(c) Write a generic interface named `iStack` with methods `push`, `pop` and `isEmpty`. Then write a generic class `Stack` that implements the `iStack` interface.

(d) Consider the following Game of Thrones characters, their status, and the number of seasons active:

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>NoOfSeasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon Snow</td>
<td>Alive</td>
<td>7</td>
</tr>
<tr>
<td>Daenerys Targaryen</td>
<td>Alive</td>
<td>7</td>
</tr>
<tr>
<td>Ned Stark</td>
<td>Dead</td>
<td>1</td>
</tr>
<tr>
<td>Joffrey Baratheon</td>
<td>Dead</td>
<td>4</td>
</tr>
<tr>
<td>Tyrion Lannister</td>
<td>Alive</td>
<td>7</td>
</tr>
</tbody>
</table>

Write Java code for the following:

(i) Declare a single Enumeration named `GOT` for the above characters.

(ii) Find out the name of the character who was active for the least number of seasons (You can’t simply write Ned Stark).

SECTION – B

There are FOUR questions in this section. Answer any THREE.

5. (a) What is the purpose of constructors and destructors? Write three special properties of a constructor that make it distinct from other member functions.

(b) Consider the following code:

```java
class Animal {
    int * age;
    public:
        Animal(int arg) { age = new int; *age = arg; }
        ~Animal() { delete age; }
};
```

What is the problem when an object of an Animal class is passed by value to a function?

What are the ways around that problem? Write a copy construct to resolve it.
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Contd ... Q. No. 5

(c) What will be the output of the following code segment?

```c++
class Animal {
    int age;
public:
    Animal() { cout << "Constructing\n"; age = 0; }
    ~Animal() { cout << "Destructing\n"; }
};

Animal process(Animal a) {
    cout << "In process\n";
    Animal b;
    b = a;
    return b;
}

int main() {
    cout << "First line\n";
    Animal a;
    cout << "Second line\n";
    Animal b = a;
    cout << "Third line\n";
    Animal c = process(b);
    cout << "Return line\n";
    return 0;
}
```

6. (a) Briefly explain the visibility of private, protected, and public members of a class in a derived class when the base class is inherited as private, protected, and public by the derived class.

(b)
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Contd ... Q. No. 6(b)

Implement a Queue class by inheriting from the List class. Your queue class should override the three functions as follows:

(i) store – override this to add a new item at the end of the queue
(ii) retrieve – override this to remove and return the value from the beginning of the queue
(iii) print – displays the queue items as a comma separated list at the stdout

7. (a) Consider the following MyInt class which simulates a user-defined integer class:

```cpp
class MyInt {
    int *x;
    public:
    MyInt(int argx) { x = new int; *x = argx; }
    int getX() const { return *x; }
    void setX(int argx) { *x = argx; }
    ~MyInt() { delete x; }
};
```

Assume that there is no copy constructor available. Overload the following operators for the MyInt class:

(i) `+` operator so that two MyInt objects can be added.

(ii) `*` operator so that a MyInt object can be multiplied by an integer (built-in) number. The integer number can be in either side of the operator. The result should be a MyInt object.

(iii) `=` operator so that one MyInt object can be safety assigned to another MyInt object.

Note that you cannot write a copy constructor for the above tasks.

(b) What is an in-line function? What are the advantages and disadvantages of using in-line functions?

(c) How does the copy constructor differ from the assignment operator (=)?
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8. (a) Suppose class A has some virtual functions and class B publicly inherits from A. What happens if class B does not implement some of the virtual functions of class A? Does the situation remain the same if the virtual functions in class A were pure virtual functions? What happens when we try to instantiate an object of class A in the second scenario mentioned above?

(b) What is the output of the following code segment?

```cpp
int& fO;
int x;

int main()
{
    int f() = 10;
    int a=10;
    int b=20;
    int& ref = a;
    ref = b;
    cout<<a " " << b " " << ref " " << x;
    return 0;
}

int& fO() { return x; }
```
(c) Explain what is wrong with the following code segment? Rewrite the code to solve the problem. What will be the output of the code once you fix it?

```cpp
class A {
    int x;
    public:
        void setX(int i) { x = i; }
        void print() { cout << x; }
    };

class B: public A {
    public:
        B() { setX(10); } // do not change the parameter value while fixing the code
    };

class C: public A {
    public:
        C() { setX(20); } // do not change the parameter value while fixing the code
    };

class D: public B, public C {
};

int main() {
    D d;
    d.print();
    return 0;
}
```