L-2/T-1/MME **Date: 11/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **MME 211** (Crystallography and Structure of Materials)

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** questions.

1. (a) Stereographic projection is a powerful method for solving geometric problems in structural geology as well as in crystallography. Examine the shape of stereographic projection for both great and small circles. Also, distinguish between great and small circles. **(20)**

   (b) Wulff nets are a type of stereographic projection which is typically used for single crystal samples such as silicon wafers in the microelectronics industry. Explain why Wulff net is the device most useful in solving problems involving the stereographic projection and how it is used. **(15)**

2. (a) In Bragg's law, $n\lambda = 2d\sin(\theta)$. Here, n is the order of the reflection, and corresponds to the path length difference between X-rays diffracted from two different layers of atoms, in terms of the number of wavelengths. Judge the statement that any higher order of magnitude diffraction can be explained from first order diffraction as well. **(20)**

   (b) With necessary schematic presentation, distinguish among the XRD patterns for two interpenetrating simple cubic and body centered cubic crystal structure. **(15)**

3. (a) With sketches show that reciprocal lattice of a BCC lattice is FCC and reciprocal lattice of an FCC lattice is BCC. **(20)**

   (b)Defects in crystals can be classified as point, line, surface, and volume defects. Distinguish among these three with examples. Also, differentiate between edge and screw dislocations. **(15)**

4. (a) Define roto-reflection and roto-inversion. With necessary sketches show that 3-fold roto-reflection and 6-fold roto-inversion are same. **(20)**

   (b) Explain the symmetry elements: (i) mirror (ii) glide (iii) inversion (iv) screw. **(15)**

Contd P/2

SECTION – B

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

5. (a) Consider a 2D crystal with purported Lattice parameters a=a, α#90°, 60°. Corner of unit cell occupied by one type of atom, centroid of unit cell another type

   (i) What is the motif of the crystal? Write out the coordinates and also number of atoms in the unit cell, assuming the unit cell in 3D is monoclinic. **(7)**

   (ii) Is this a valid description of crystal system? Why or why not? Can you rearrange the unit cell to better reflect inherent symmetry of this crystal? Write down Pearson symbol for this structure. **(8+2=10)**

   (b) Sketch to reconstruct the FCC Lattice as hexagonal lattice with 3 stacking layer (instead of 2 stacking layers of HCP). Find location of Lattice points, Octahedral and Tetrahedral voids- first in 3-index system and then in 4-index system. **(6+(6×2)=18)**

6. (a) Calculate $\frac{NN}{r_{NN}^{k}}+\frac{NNN}{r_{NNN}^{k}}$ for BCC, SC, FCC or HCP. Here k is an unknown constant. NN is (number of) nearest neighbour and NNN (number of) next nearest neighbour. The distance r_{NN} or r_{NNN} indicates center-to-center distance between an atom and its nearest or next-nearest neighbour. Set k=2, and compute the aforementioned sum for SC, BCC, FCC and HCP for a fixed atomic radius r. It is said that, this sum is maximum for BCC, especially valid for alkali metals. Does putting k=2 justify this assertion? **(4×5+4=24)**

   (b) Consider a kind of phase transition that doesn't change geometric arrangement of lattice points; but at high temperature, it causes so rapid swapping of atoms between two non-identical lattice sites that, those lattice sites eventually become identical. This kind of transition is called order to disorder transition, not strictly a phase transition like solid-liquid-gas, but more like a solid state phase transition.

   (i) Explain whether this transition make the material more or less crystallographically symmetric. **(6)**

   (ii) Correlate this trend with symmetry vs temperature for usual phase transitions involving solid, liquid gas etc. **(5)**

Contd P/3

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7. (i) What would be elevated Packing factor for FCC if, along with lattice points, only octahedral voids are filled? Only tetrahedral voids are filled? Is it possible to simultaneously fill both type of voids (i.e. radii sum of tetrahedral and octahedral void atoms less than or equal to their centre-to-centre distance)? If yes, then what is the packing factor if both voids are fulfilled? **(2×(4+4+4+3+2½=35)**

(ii) Redo whole calculation with BCC.

Use sketches whenever necessary.

8. (a) Calculate Planar density expressed in terms of atomic diameter, and Fraction of plane occupied by atoms for (111) planes for α-Po and Cu like crystal structure. Which of the crystal structures would be more prone to slip on that direction? **(4×4+2=18)**

(b) Look for planes that cut the hexagonal unit cell in a trapezoidal shape rather than rectangle, hexagonal or square. There are 12 such planes. Choose two of such adjacent planes such that their zone axis not parallel to any unit cell axis. What is angle between the planes? Explain with proper drawing. Be sure to index lines and planes consistently to calculate the angle. **(17)**

L-2/T-1/MME **Date: 06/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **MME 215** (Thermodynamics of Materials)

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** questions.

1. (a) Establish the conditions that a solution must fulfill of becoming an ideal solution. How does non-ideal solutions deviate from ideality? List the characteristics of a regular solution. **(6+4+4=14)**

   (b) The vapor pressure of liquid zinc as a function of temperature is given as: **(15)**

   $$\log P \text{ (mm Hg)} = -6620/T - 1.255 \log T + 12.34$$

   Calculate the heat of vaporization of zinc at its boiling point 907°C. If the heat of sublimation of zinc at the boiling temperature is 30 Kcal/mol, what will be the heat of fusion of zinc at its boiling temperature?

   (c) Draw free energy - composition diagrams of the phase diagram given in Figure1 and T_1 and T_2 temperatures. **(6)**

2. (a) Deduce an expression between the pressure and temperature at which a liquid phase and a gaseous phase of a unary system can exist in equilibrium. List all assumptions you made while deducing this equation. Indicate three probable applications of this expression. **(15+2+3=20)**

   (b) Analyse the concept of macrostate and microstate in statistical thermodynamics. **(6)**

   (c) Explain the concept of wettability and its application in metallurgical process. **(9)**

3. (a) Using suitable examples, analyse the use of the equilibrium constant in controlling the furnace atmosphere to prevent rusting during heat treatment of steel. **(10)**

   (b) Mercuric oxide (HgO) solid is placed in a vessel which is then evacuated, filled with nitrogen, and heated to 600 K. At this temperature the total pressure in the vessel is 2 atm. Calculate the mole fractions of O_2 and Hg vapor in the gas phase. Given data: $(Hg) + 1/2\ (O_2) = <HgO>$; $\Delta G_o = -152200 + 207.2\ T$ Joules. **(15)**

   (c) Using thermodynamic principles, explain the functions of detergent in a cutting fluid and potassium ethyl xanthate in the froth flotation concentration process of galena. **(10)**

Contd P/2

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4. (a) Calculate the phase diagram of water using the following data: **(20)**

$T_m = 273$ K, $T_b = 373$ K, $\Delta H^F = 1436$ Cal/mol, $\Delta H^V = 9717$ Cal/mol

Indicate clearly all assumptions you made to solve this problem.

(b) Copper and gold form complete ranges of solid solution at temperatures between 410 and 889°C. The excess molar Gibbs free energy of formation of solutions at 600°C is given as **(15)**

$G^{ex} = -28280\ X_{Au}\ X_{Cu}$. Calculate the activities of Au and Cu exerted by the solid solution containing $X_{Cu} = 0.6$ at 600°C.

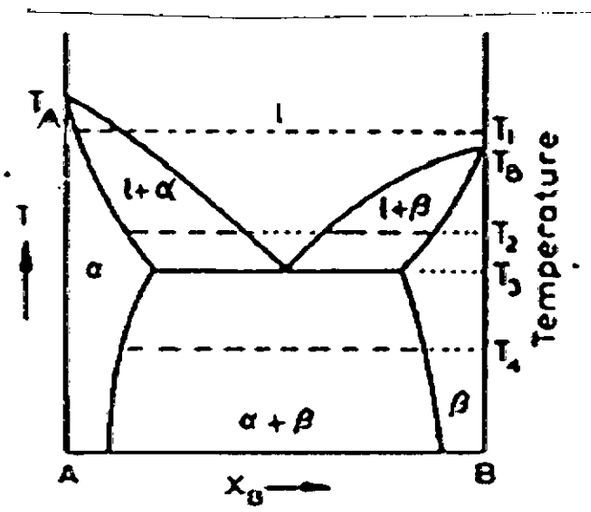

Figure 1 for Question 1.(c)

SECTION – B

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

5. (a) You are a materials scientist working on a solar device. The device consists of a titanium dioxide (TiO_2) layer grown on top of a cesium tin triiodide ($CsSnI_3$) layer. The Sn^{2+} ions of $CsSnI_3$ have a tendency to react with the surrounding atmospheric oxygen resulting in a loss of Sn. The device is connected to an external circuit via two terminals for efficient extraction of the produced electrical energy. From the perspective of thermodynamics, classify this system. Explain the reasoning and assumptions behind your classification. **(10)**

(b) Consider the following multivariable scalar-valued function, $z = 54u^4 \cos(x)$. Derive the total differential of the given function. Identify the coefficients of the two differentials in this equation and determine whether or not this function is a state variable. **(10)**

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Contd.... for Q. No. 5

(c) A steel component weighing 55 kg was held at a temperature of 950 °C for some time before being quenched in an oil tank which was at 28 °C. The quenching tank had a volume of 2.6 m^3. Calculate the change in entropy of the steel component and the oil. Also, calculate the total change in entropy, mentioning all simplifying assumptions. Briefly explain why all the entropy changes are consistent with the second law. Data for heat capacity of steel = 0.5 kJ/kg-K, heat capacity of oil = 0.25 kJ/kg-K, density of steel = 7850 kg/m^3 and density of oil = 850 kg/m^3. **(15)**

6. (a) Consider a system where the initial and final states are described by their pressure and volume. Derive a thermodynamic relationship that can be used to measure the change in Helmholtz free energy for such a system. How would this relationship simplify if the system was changed at constant pressure? **(20)**

(b) You are a metallurgist working on Aluminium alloys. At high temperatures, the solubility of Lithium in Aluminium is greater than its solubility at room temperature. Using this fact, you have designed a supersaturated solid solution of Lithium in Aluminium by rapidly quenching the system to room temperature. Which one of the following descriptions of state will best describe this system: stable equilibrium, unstable equilibrium, metastable equilibrium or steady state? Give sufficient reasoning to support your answer. **(10)**

(c) Distinguish between entropy transfer and entropy production in the context of a thermodynamic system. **(5)**

7. (a) Derive a thermodynamic relationship for the change in the temperature of a system to its entropy and pressure. Now consider the following scenario. One mole of copper initially at 750 K and 1 atm is contained in a thermally insulated jacket. The system is then compressed reversibly to a pressure of 9500 atm. Compute the final temperature for this reversible adiabatic process using the relationship you derived. Given Data for copper: V = 7.09 cc/mol, $\alpha = 51\times10^{6}K^{-1}, C_p = 27.3$ J/mol.K. **(20)**

(b) The change in internal energy of a unary, single-phase system may be written as: **(15)**

$$dU' = TdS' - PdV' + \mu dn$$

Use this result to write expressions for the change in internal energy of a two-phase (A+B) system. If the system is constrained to constant entropy, volume and quantity of each of its components, then derive the conditions for equilibrium. **(15)**

Contd P/4

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8. (a) One mole of an ideal gas with Cp = (5/2)*R and Cv = (3/2)*R expands from P1 = 9.5 bar and T1 = 600 K to P2 = 1.2 bar by each of the following paths: **(20)**

   (i) Constant temperature

   (ii) Adiabatically.

   Assuming mechanical reversibility, calculate W, Q and change in internal energy for each process.

   (b) Under which assumption can be entropy of matter at absolute zero temperature be taken as zero? Give a counter-example where this assumption would not hold true. **(8)**

   (c) Distinguish between extensive and intensive variables. How can extensive variables be transformed into intensive variables? **(7)**

L-2/T-1/MME **Date: 04/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **PHY 201** (Physics-III)

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** questions.

1. (a) Describe the terms associated with nanomaterials: (i) Nanoparticle (ii) Nanowire (iii) Nanotube, and (iv) Nanocomposite. **(12)**

   (b) Draw a comprehensive flow chart to demonstrate classifications of nanomaterials. Write down some examples of the zero, one and two dimensional nanomaterials. **(13)**

   (c) Why the size of the nanoparticles is generally considered as 1 to 100 nm? What are the potential applications of nanoparticles? **(10)**

2. (a) Draw schematically the top-down and the bottom-up approaches for the synthesis of nanostructured materials. Write down some examples of the top-down and bottom up approaches. **(12)**

   (b) Describe mechanical milling and ultrasonication technique for the synthesis of nanomaterials from their bulk counterparts. **(13)**

   (c) Draw schematically different steps for the synthesis of nanomaterials using hydrothermal and sol-gel techniques. What are the advantages and disadvantages of these two techniques? **(10)**

3. (a) How optical microspore is different than electron microscope? What is the basic principle to determine the resolution of an electron microscope? **(12)**

   (b) Show schematically different components of a conventional transmission electron microscope (TEM). Why TEM is preferable for imaging nanostructured materials? **(13)**

   (c) What kind of substrate should be used to investigate thin films using an electron microscope? Explain thermal evaporation technique for thin film deposition. **(10)**

4. (a) What do you mean by normalization of the wave function? Briefly describe how a wave function can be normalized. **(12)**

   (b) A wave function is defined as **(13)**

$$\psi(x,0)=\begin{cases} 5x^2 & -5<x<5 \\ \dfrac{7-x}{3} & 5<x<10 \\ 0 & \text{otherwise} \end{cases}$$

   (i) Normalize the wave function.

   (ii) Plot $\psi(x,0)$ as a function of x.

   (iii) What is the probability of finding the particle to the right of $x = 0$?

   (c) Show that if a wave function is normalized at $t = 0$ then it is normalized all the time. **(10)**

Contd P/2

SECTION – B

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

5. (a) Distinguish between the expectation value and the average value. **(5)**

(b) State and prove Ehrenfest's theorem. Hence, describe the physical significance of this theorem. **(15)**

(c) The wave function for a particle is given by $\psi(x,0) = Ae^{-(i\omega t + 5x^2)}$, where A and ω are constants. Find out the expectation value of the (i) position, (ii) momentum, and (iii) kinetic energy of the particle. **(15)**

6. (a) Derive time-independent Schrödinger equation. **(7)**

(b) Assume that a particle having mass m is kept under the influence of a potential defined as **(14)**

$$V(x) = \begin{cases} 0 & \text{for } -a/2 < x < a/2 \\ \infty & \text{otherwise} \end{cases}.$$

Find out the wave function for the particle.

(c) A particle in the infinite square well has its initial wave function as an even mixture of the first and third stationary states: **(14)**

$$\psi(x,0) = A[\psi_1(x) + \psi_3(x)],$$

where A is a constant

(i) Normalize $\psi(x,0)$

(ii) Find $\psi(x,t)$

(iii) Compute $\langle x \rangle$

7. (a) State the basic postulates of special theory of relativity. **(8)**

(b) Derive the Lorentz space-time transformation formulae and hence show that the Galilean transformation is a special case of Lorentz transformation. **(19)**

(c) Show that the momentum (p) of a particle of rest mass m_0 and kinetic energy K_E is given by the expression, $p = \sqrt{\frac{K_E^2}{c^2} + 2m_0K_E}$, where c is the velocity of light. **(8)**

8. (a) Discuss the experimental observations of the photoelectric effect from a quantum point of view. **(15)**

(b) Sketch the curve of the binding energy per nucleon for the most stable nucleus against the corresponding mass number and discuss its nature. What information can you obtain from this curve? **(12)**

(c) The mass of ${}_{17}Cl^{35}$ is 34.9800 *amu*. Calculate its binding energy. What is the binding energy per nucleon? Mass of ${}_0n^1 = 1.008665$ *amu* and ${}_1H^1 = 1.007825$ *amu*. **(8)**

L-2/T-1/MME **Date: 30/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **MATH 273** (Matrices, Series Solution and Fourier Analysis)

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** questions.

1. (a) Solve the system of homogeneous equations **(18)**

$$\begin{aligned} 2x_1 + 2x_2 - x_3 \quad\quad + x_5 &= 0 \\ -x_1 - x_2 + 2x_3 - 3x_4 + x_5 &= 0 \\ x_1 + x_2 - 2x_3 \quad\quad - x_5 &= 0 \\ x_3 + x_4 + x_5 &= 0 \end{aligned}$$

by reducing the coefficient matrix to the canonical form (Gauss-Jordan elimination).

(b) Write down the following system of equations **(17)**

$$\begin{aligned} x + 2y + 3z &= 5 \\ 2x + 5y + 3z &= 3 \\ x \quad\quad + 8z &= 17 \end{aligned}$$

in the matrix form AX=B. Find A^{-1} and get the solution of the system using A^{-1}.

2. (a) Reduce the matrix $A = \begin{bmatrix} 2 & 7 & 3 & 5 \\ 3 & 9 & 6 & 9 \\ 3 & 8 & 1 & -2 \\ 4 & 13 & 1 & -1 \end{bmatrix}$ to echelon form then to its canonical form and write down the rank and nullity. **(17)**

(b) Find non-singular matrices P and Q such that PAQ is in the normal form, where **(18)**

$$A = \begin{pmatrix} 3 & 2 & -1 & 5 \\ 5 & 1 & 4 & -2 \\ 1 & -4 & 11 & -19 \end{pmatrix}.$$

3. (a) State Cayley-Hamilton theorem and verify it for the matrix $A = \begin{pmatrix} 6 & 2 & -2 \\ 2 & 3 & -1 \\ -2 & -1 & 3 \end{pmatrix}$ and hence find the inverse of A. **(17)**

(b) Find the eigen values, eigen vectors and eigen spaces of the matrix, $A = \begin{pmatrix} 0 & 0 & -2 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{pmatrix}$. Is the matrix A diagonalizable? **(18)**

4. (a) Determine whether the following matrix is diagonalizable. If so, find a nonsingular matrix P that diagonalizes A, and write down the diagonal matrix D so that $P^{-1}AP = D$, where $A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}$ **(18)**

Contd P/2

MATH 273/MME

Contd.... for Q. No. 4

(b) For the symmetric matrix $A=\begin{pmatrix}0 & 1 & 1\\ 1 & -2 & 2\\ 1 & 2 & -1\end{pmatrix}$ find nonsingular matrix P such that $P^TAP = D$ (a diagonal matrix). Write down the rank index and signature. Identify the geometrical object represented by $X'AX$ = constant. **(17)**

SECTION – B

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

5. (a) Graph the function **(20)**

$$f(x)=\begin{cases}x+1, & -1<x<0\\ x-1, & 0<x<1\end{cases}$$

Then find the Fourier series of $f(x)$.

(b) Expand $f(x)=x,\ 0<x<2$ in a half-range Fourier cosine series. Then write Parseval's identity corresponding to this series and hence find the sum of $\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+\cdots$. **(15)**

6. (a) Find the Fourier sine and cosine integral formula for $f(x)=e^{-ax}$ for $x\geq 0$. **(10)**

(b) Find the Fourier transform of **(10)**

$$f(x)=\begin{cases}x, & 0<x<1\\ 2-x, & 1<x<2\\ 0, & x>2\end{cases}$$

(c) Use Fourier transform to solve the boundary value problem **(15)**

$$\frac{\partial u}{\partial t}=3\frac{\partial^2 u}{\partial x^2},\quad 0<x<\pi,\quad t>0$$

where $u(o,t)=0$, $u(\pi,t)=0$, $t\geq 0$ and $u(x,0)=1-\cos(\pi x)$, $0\leq x\leq \pi$.

7. (a) Use Fröbenius method to solve the differential equation **(25)**

$$2x\frac{d^2y}{dx^2}+(x+1)\frac{dy}{dx}+y=0.$$

(b) Express $f(x)=x^4+2x^3+2x^2-x-3$ in a series of Legendre polynomials. **(10)**

8. (a) Use recurrence formula and orthogonal property for Legendre polynomials to find $\int_{-1}^{1}x^2P_{n-1}(x)P_{n+1}(x)dx$. **(12)**

(b) Prove that $\frac{d}{dx}[J_2(x)]=\left(1-\frac{4}{x^2}\right)J_1(x)+\frac{2}{x}J_0(x)$ **(12)**

where $J_n(x)$ is the Bessel's function of order n.

(c) Find the first order derivative of $xJ_n(x)J_{n+1}(x)$ with respect to x. **(11)**

L-2/T-1/MME **Date: 28/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **CSE 287** (Computer Programming)

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** questions.

Assume system clock frequency 1MHz if not given.

List of registers and necessary diagrams are at the end of the question.

If configuration for any required register is missing, just assume a configuration and clearly show the assumed configuration.

If any control word/bit configuration is missing in the question paper, just assume a pattern of your choice and clearly mention your assumption.

1. (a) Write a C program using *switch-case* that will take a number ***n(n>0)*** as input from the user and do the following: **(12)**

   (i) If the number of digits in ***n*** is odd and at least 3, then print the middle digit.

   (ii) If the number of digits in ***n*** is even and at least 4, then print the two middle digits.

   (iii) If the number of digits in ***n*** is odd but less than 3, or even but less than 4, then print "No middle digit!"

   (iv) In all other cases, just print "The number is too big!".

   [You cannot use any *if-else* or loops in your code.]

   (b) Check the following code snippets carefully and find out syntax error(s) if any. **(8)**

```
1  #include <stdio.h>
2  int main() {
3      float _f;
4      int a_;
5      char C = "A";
6      scanf ("%d%f", &a_,&f);
7
8      if (a=C)
9      {
10       printf("%d", C);
11     } else
12     {
13        break;
14     }
15
16     return 0;
17 }
```

Figure for Q1(b)

Contd P/2

CSE 287

Contd.... for Q. No. 1

(c) Suppose we have defined 3 variables ***num*** (integer), ***fl_num*** (float), and ***l_num*** (long) and want to print their values. Write appropriate (correct) print statements to perform the following printing operations. **(8)**

(i) Print ***num*** so that the output is always of 10 digits width. If the value contains less than 10 digits, then it will be right justified and its left side will be filled up by spaces.

(ii) Print ***num*** in the hexadecimal representation. Use uppercase letters A-F.

(iii) Print ***fl_num*** after 2 digits of the decimal point.

(iv) Print the value of ***l_num***.

(d) Explain the key differences between *signed* and *unsigned int*. Write down four rules for naming variables in C with appropriate examples. **(7)**

2. (a) Write a C program that will take an integer ***n*** as input and generate a triangular pattern with ***n*** rows with the odd digits of **1-9** as shown below (Table for Q2(a)). Check carefully how the digits are repeated. **(12)**

2	1 3 5
5	1 3 5 7 9 1 3 5 7 9 1 3 5 7 9 1

Table for Q2(a)

(b) We want the following loop to print **4321**. However, there seems some bugs in the code for which we are not getting the expected output. Write down the output of this faulty program. What modification is needed to get the expected output? **(8)**

```
int i = 4;

while(i)
{
   printf("%d ", i++);

   If (i==1) continue;
   i - -;
}
```

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Contd.... for Q. No. 2

(c) Answer the following questions from the given C program. **(10)**

```
#include <stdio.h>
int var = 5;

int main() {
  int a = 10, b =10;
  printf("%d\n", a);
  func();
  printf("%d\n", var);

  return 0;
}

void func()
{
  int x = var;
  printf("%d\n", var);
  var += 1;
}
```

Figure for Q 2(c)

(i) List the global and local variables of the program.

(ii) What is the scope of the variable x? Can we print x's value from inside the main function?

(iii) Write down the output of the above program.

(d) Explain the difference between **break** and **continue** with appropriate examples. **(5)**

3. (a) Write a recursive function in C named ***removeDigit(int n, int i)*** that will remove the last i digits from a number n and return the modified number. **(10)**

(b) Write a C program that will take two **sorted** integer arrays as input and merge them into one. While merging, you have to make sure that the merged array remains sorted. Note, you cannot merge at first and sort later but need to merge in a way that the new array becomes sorted. Some examples are given below for your reference. **(15)**

Input	Output
5 7 9 6 8 10	5 6 7 8 9 10
1 2 3 5 1 1 1 1	1 1 1 1 1 2 3 5

Table for Q 3(b)

(c) Write a C program that will take an integer n followed by an $n \times n$ matrix as input and check whether the matrix is an identity matrix or not. If yes it will print "Yes" and "No" otherwise. [A square matrix is an identity matrix if the main diagonal elements are 1 and all other elements are 0. For example, $\begin{matrix}1&0&0\\0&1&0\\0&0&1\end{matrix}$ is an identity matrix of dimension 3] **(10)**

Contd P/4

CSE 287

4. (a) Suppose you are given a binary string i.e., a string consisting of only 0 and 1. You have to write a C program to find out the maximum length of consecutive 0's as given below. **(15)**

Input	Output
100011011000001	5
0010	2
11111	0

Table for Q 4(a)

(b) In the following C program, we wanted the pointers p and q to point at num1 and num2 respectively. However, this is not happening due to bugs. **(8)**

```
#include <stdio.h>

int main() {
    int *p, *q, num1 = 10, num2 = 20;
    int arr[3] = {2, 20. 200};

    p = num1;
    q = num2;

    printf("%d %d", *p, *q);

    p = arr;
    printf("%d", p + 2);

    return 0;
}
```

Figure for Q 4(b)

(i) Fix the code so that the first print statement prints the value **10 20**.

(ii) What value will the second print statement print and why?

(c) Write a C program that will take a string as input and change the cases of the alphabetic characters and remove all non-alphabetic characters such as digits, punctuation marks etc. If there is no alphabetic character, it will print '-'. **(12)**

Input	Output
ABC123,def	abcDEF
'aa-aa'	AAAA
12345	-

Table for Q 4(c)

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SECTION – B

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

5. (a) A complex number $a+ib$ consists of a real part a and an imaginary part b, where both a and b are real numbers. Define a structure for storing complex numbers in C programs. Implement the following functions: **(15)**

   (i) *add()*: this function takes two complex numbers as parameters, adds them, and returns the result as a complex number.

   (ii) *multiply()*: this function takes two complex numbers as parameters, multiplies them, and returns the result as a complex number.

   (iii) *findmax()*: receives an array of complex numbers as parameter, finds the one which has the highest modulus, and returns it. Note that modulus of a complex number $a+ib$ is $\sqrt{(a^2+b^2)}$.

   (b) Briefly explain *function overloading* and *function overriding* using suitable examples in C++. Can the following code segment (that declares two function prototypes) be considered an example of function overloading? Why or why not? **(10)**

   ```
   float func(int x);      double func(int y);
   ```

   (c) Why is reading a binary file different than reading a text file? Briefly discuss two C library functions which can be used for formatted I/O operations in text files. **(10)**

6. (a) A warehouse management program needs to design a C++ class to represent the articles in stock. Answer the following questions. **(20)**

   (i) Define a class named *Article* using the following data members: article number, article title, article publication date, and sales price. Use appropriate data types.

   (ii) Define a global variable for counting the number of *Article* type objects. The value of this variable will denote the number of *Article* objects existing at program run-time.

   (iii) Implement an all-parameter constructor and a destructor for the class. The constructor and destructor should ensure that the global counter for the number of objects shows the correct value at any time.

   (iv) Suppose you declare an array of objects in the main function as follows:
   Article articles[10];
   You found that the counter for the number of object becomes negative after running the program with the above statement. Why? Give a solution to the problem.

   (b) Suppose a text file named "wordlist.txt" contains a list of words, where each word is in a separate line in the file. Write down a C program which reads all the words from the file, counts the frequency of each word, and writes the results in a new file "word_frequency.txt". Each line in the output file should contain a word and the frequency count of the separated by a space. **(15)**

Contd P/2

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7. (a) Consider the following C++ class *IntList*. **(18)**

Consider the following C++ class *IntList*.

```
class IntList
{
private:
        int values[MAX]; // array for storing values
        int count; // number of elements in the array
public:
        IntList(){ count = 0; }
        int search(int val);
        int append(int val);
        int erase(int val);
};
```

The class *IntList* is designed to manage a simple list of integer values. Each entry in the list is an integer number. The array *values* can store up to MAX entries. The data member *count* records the number of elements currently stored in the array. When a list is initially created, this count will be 0. When an element is inserted or deleted, the number is modified accordingly.

(i) Implement the *search*() method that returns the position (i.e., index) in the array that contains the search value (received as function parameter *val*). If the search operation is unsuccessful, the value –1 is returned.

(ii) Implement the *append*() methods that adds a new entry (received as function parameter *val*) at the end of the list. The method returns 1 if the addition is successful. If there is no space available, or the value is already in the list, nothing happens. In this case, the method returns –1.

(iii) The method *erase*() deletes an array element. Use the *search*() method to locate the element (denoted by the function parameter *val*). Then use the last element in the array to overwrite the element that is to be deleted. If the element does not exist, *erase*() returns–1; otherwise returns 1.

(b) Write down a C function *copycheck(filename1, filename2)*. The function receives two filenames as parameters. The function should return true if the two files have exactly same contents excluding whitespaces, i.e., the two files are exactly same if you ignore the whitespace characters (space, newline, and tab). The function returns false otherwise. **(12)**

(c) Write down a C code segment demonstrating the use of EOF in file operations. **(5)**

8. (a) A supermarket chain has asked you to develop an automatic checkout system. All products are identifiable by means of a *name*. Pre-packed goods have fixed *prices*. Fresh goods (e.g., Groceries and meats) are sold by *weight*, and the price of fresh goods is calculated by multiplying the *weight* by the *price per kilo*. Answer the following questions. **(18)**

Contd P/7

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Contd.... for Q. No. 8(a)

(i) Develop three classes needed to represent the products and organize them hierarchically. The *Product* class, which contains generic information on all products can be used as a base class. Define a constructor with parameters for the data members. Define a method named *printer*() that simply outputs the generic product information on the screen.

(ii) Define two other classes derived from the *Product* class, *PrepackedFood* and *FreshFood*. In both classes, define a constructor with parameters providing values for all data members. Also redefine the *printer*() method in both classes to print the price of the product along with other generic information.

(b) You want to implement a dictionary that contains a list of words along with their definitions. For example, "Computer" is a word and "An electronic machine" is it's definition. Write down a C program to implement the following. **(17)**

(i) Define a C structure with two members for storing the word and word definition. Declare an array of this structure globally in your program which will be used by the below functions.

(ii) Implement a function named *load*(): This function reads N words and their definitions from the user and stores them in the global array of structure. Value of N will be entered by the user.

(iii) Implement a function named *sort*(). This function sorts the array of structure alphabetically in ascending order of words (to mimic a valid dictionary order).
