SECTION – A

There are FOUR questions in this section. Answer any THREE.
Symbols bear their usual meanings.

1. (a) Calculate the equivalent resistances \( R_{ab} \) and \( R_{cd} \) in the circuit shown in Fig. for Q. No. 1(a).

\[ \text{Fig. for Q. No. 1(a)} \]

(b) Refer to the circuit shown in Fig. for Q. No. 1(b).
(i) Find the currents \( I_1 \), \( I_2 \) and \( I_3 \).
(ii) Solve for the voltage \( V_{ab} \).
(iii) Verify that the power delivered to the circuit is equal to the summation of power dissipated by the resistors.

\[ \text{Fig. for Q. No. 1(b)} \]

2. (a) Determine the power delivered/absorbed by the 2A current source shown in Fig. for Q. No. 2(a).

\[ \text{Fig. for Q. No. 2(a)} \]

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

(b) Find the voltage gain \( A_v = \frac{V_o}{V_i} \) in the circuit shown in Fig. for Q. No. 2(b).

\[ V_o = 2 \text{V} \]

\[ V_i = 1 \text{V} \]

![Fig. for Q. No. 2(b)](image)

3. (a) In the circuit shown in Fig. for Q. No. 3(a), find the terminal voltage \( V_{ab} \) using superposition theorem.

\[ V_{ab} = 10 \text{V} \]

![Fig. for Q. No. 3(a)](image)

(b) Use source-transformation to find \( i_x \) in the circuit shown in Fig. for Q. No. 3(b).

4. (a) Obtain the Norton equivalent of the circuit shown in Fig. for Q. No. 4(a) to the left of terminals x-y. Use the result to find the current \( i \).

\[ i = 2 \text{A} \]

![Fig. for Q. No. 4(a)](image)
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Contd... Q. No. 4

(b) Compute the value of $R$ that results in maximum power transfer to the $10 \, \Omega$ resistor shown in Fig. for Q. No. 4(b). Find the maximum power.

![Circuit Diagram](image)

$\text{SECTION - B}$

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

5. (a) Find the voltage across each of the capacitors in Fig. 5(a).
   (b) If the waveform in Fig. 5(b)(i) is applied to the circuit of Fig. 5(b)(ii), find $v(t)$. Assume $v(0) = 0$. Also calculate $v(0.5)$ and $v(2)$.

6. (a) In the circuit of Fig. 6(a), let $i_1 = 30e^{-2t}$ mA and $v_1(0) = 50 \, V$, $v_2(0) = 20 \, V$. Determine (i) $v_1(t)$ and $v_2(t)$ (ii) the energy in each capacitor at $t = 0.5 \, s$.
   (b) Determine $L_{eq}$ that may be used to represent the inductive network of Fig. 6(b) at the terminals.

7. (a) Switch $S_1$ in Fig. 7(a) is closed at $t = 0$, and switch $S_2$ is closed at $t = 2 \, s$. Calculate $i(t)$ for all $t$. Find $i(1)$ and $i(3)$.
   (b) Find $v(t)$ for $t < 0$ and $t > 0$ in the circuit of Fig. 7(b).

8. (a) Determine the current $I$ required to establish a flux of $1.8 \times 10^{-4}$ Wb in the airgap in Fig. 8(a).
   (b) Determine the magnetic flux $\phi$ established in the series magnetic circuit of Fig. 8(b).
Sheet steel

Given
\( N = 50 \)
Area (throughout) = \( 6 \times 10^{-4} \, \text{m}^2 \)
\( l_{bcde} = 0.2 \, \text{m} \)
\( l_{defa} = 0.1 \, \text{m} \)
\( l_{xz} = l_{ey} = 2.5 \, \text{cm} \)

\[ \Phi = 4 \, \text{m} \]

\( \phi_1 - \phi_2 \)

\( l_{gap} = 0.2 \, \text{mm} \)

\[ Y_{cd} = 8 \times 10^{-4} \, \text{m} \]
\[ l_{ab} = l_{be} = l_{ef} = l_{fa} = 0.2 \, \text{m} \]
Area (throughout) = \( 2 \times 10^{-4} \, \text{m}^2 \)
\( l_{bc} = l_{de} \)
B-H curve for α(8)
B-H curve for $\alpha(\beta)$
SECTION - A

1. (a) Explain the terms: isothermal, adiabatic, isochoric and isobaric processes. (10)
   (b) Prove that $PV = \text{constant}$, where the symbols have their usual meanings. (18)
   (c) Two grams of hydrogen gas at 27 °C are isothermally compressed to one-fourth of the initial volume. Determine the amount of work done during the process. ($R = 8.31 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$). (7)

2. (a) Explain the main reasons for correction of the ideal gas equation. (7)
   (b) Derive Van der Waals' equation of state for a real gas. (16)
   (c) Define the critical constants of a gas. Find expressions for the critical constants in terms of the Van der Waals' constants. (12)

3. (a) Why Maxwell's thermodynamic relations are necessary? (6)
   (b) Derive Maxwell's thermodynamic relations. (22)
   (c) Calculate under what pressure ice would freeze at -1 °C if the change in specific volume is 0.091 cm$^3$ when 1 gram of water freezes into ice. [Latent heat of fusion of ice = 80 cal·g$^{-1}$, $J = 4.2 \times 10^{-7}$ erg·cal$^{-1}$ and 1.0 atmosphere pressure = 10$^5$ degrees·cm$^{-1}$] (7)

4. (a) What is Fraunhofer diffraction? (3)
   (b) Obtain an expression of intensity for Fraunhofer diffraction at a double slit. (26)
   (c) Find the missing orders in a double slit diffraction pattern. (6)

SECTION - B

5. (a) State the conditions of interference pattern. (4)
   (b) Find the expression of fringe width in case of Young's double slit experiment. (14)
   (c) Give Stoke's treatment to explain the change of phase of light on reflection. (12)

Contd .......... P/2
(d) In a Young's double slit experiment, a thin sheet of transparent material of thickness $7.2 \times 10^{-4}$ cm is introduced in the path of one of the interfering beams. The central fringe shifts to a position occupied by six bright fringes. If the wavelength of light is $6 \times 10^{-5}$ cm, find the refractive index of the sheet.

6. (a) Write down the names of processes by which an unpolarized light can be polarized.

(b) (i) Discuss how a plane polarized light can be circularly polarized. (ii) A beam of circularly polarized light falls on a polarizing sheet. Determine the ratio of intensities between incident and emergent beams.

(c) A plane polarized light wave of amplitude $E_0$ falls a calcite quarter wave plate with its plane of vibration at $45^\circ$ to the optic axis of the plate, which is taken as the $y$-axis. If the emerging light is circularly polarized, determine the direction at which the electric field vector rotates.

(d) A quartz quarter wave plate is to be used with sodium light of wavelength $5890 \text{ Å}$. What must be its thickness if the refractive index for $e$-ray is 1.553 and that for $o$-ray is 1.544?

7. (a) Define power dissipation and quality factor in damped harmonic oscillation. Show that the average power dissipation of a damped harmonic oscillator is $2\alpha E$, where the symbols have their usual meaning.

(b) Illustrate the general nature of the phase lag of a driven oscillator as the driven frequency gradually increases and passes through the natural frequency of the oscillator for the case of zero, low and medium damping.

(c) Find whether the discharge of a condenser for an inductive circuit is oscillatory; given that $C = 0.1 \ \mu F$, $L = 10 \ \text{mH}$, and $R = 200 \ \Omega$. Calculate its quality factor and frequency of oscillation.

8. (a) Define energy density of a plane progressive wave. Show that the energy density of a plane progressive wave is given by $2\pi a^2 \rho \gamma^2$, where the symbols have their usual meaning.

(b) Define group velocity and phase velocity and obtain a relation between the two.

(c) Justify which of the followings is a solution of one dimensional progressive wave equation.

\[ y = 2 \sin x \cos vt \]
\[ y = \sin 2x \cos vt \]
SECTION – A

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

Symbols used have their usual meaning.

1. (a) Test the continuity and differentiability at \( x = 0 \) of the function

\[
f(x) = \begin{cases} x^2 \cos \frac{1}{x}, & x \neq 0 \\ 0, & x = 0 \end{cases}
\]

Also sketch the graph of \( f(x) \).

(b) If \( y = (\sin^{-1}x)^2 \) then find the relation connecting \( y_{n+2}, y_{n+1} \) and \( y_n \), and hence expand \( (\sin^{-1}x)^2 \) in powers of \( x \).

2. (a) If \( u = (x^2 + y^2 + z^2)^{\frac{m}{2}} \) then find the values of \( m \) which will make

\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = 0.
\]

(b) Evaluate the following:

(i) \( \lim_{x \to 1} \frac{x}{x - 1} - \frac{1}{\ln x} \)

(ii) \( \lim_{x \to 0} \left( \tan x \right)^{\frac{1}{x}} \)

3. (a) Find the volume of the greatest cylinder which can be inscribed in a cone of height \( h \) and semi-vertical angle \( \alpha \).

(b) Find the asymptote of the curve \( 4x^4 - 5x^2y^2 + y^4 + 3x^2y + 5x - 8 = 0 \).

4. (a) If \( lx + my = 1 \) touches the curve \( (nx)^n + (my)^n = 1 \) then show that

\[
\left( \frac{1}{a} \right)^{n-1} + \left( \frac{m}{b} \right)^{n-1} = 1.
\]

(b) Find the radius of curvature and centre of curvature of the curve \( \frac{2}{x^2} + \frac{2}{y^3} = \frac{2}{a^3} \).

Contd ………… P/2
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SECTION 8

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

5. Workout the following integrals:
   
   \[(a) \int \frac{dx}{\sin(2x-a)\cos(2x-b)} \quad \text{(10)}\]
   \[(b) \int (x-3)^3 \sqrt{6x-x^2} \, dx \quad \text{(12)}\]
   \[(c) \int \frac{x^2 \, dx}{(x \sin x + \cos x)^2} \quad \text{(13)}\]

6. (a) Obtain a reduction formula for \( \int x^n \cos nx \, dx \) and hence evaluate
   \[\int x^2 \cos 3x \, dx \quad \text{(13)}\]
   
   (b) Evaluate:\n   \[\lim_{n \to \infty} \left[ \left( 2 + \frac{1}{n^2} \right)^{\frac{3}{2}} \left( 2 + \frac{2^2}{n^2} \right)^{\frac{3}{2}} \left( 2 + \frac{3^2}{n^2} \right)^{\frac{3}{2}} \cdots \left( 2 + \frac{n^2}{n^2} \right)^{\frac{3}{2}} \right] \quad \text{(11)}\]
   
   (c) Find the value of:\n   \[\int_0^{\frac{\pi}{2}} \frac{\sin^2 x}{1 + \sin^2 x} \, dx \quad \text{(11)}\]

7. (a) Evaluate:\n   \[\int_0^1 \log \left( \frac{1+x}{1+x^2} \right) \, dx \quad \text{(12)}\]

   (b) If \( (a + b) > 0 \), then show that:\n   \[\int_0^\infty \frac{dx}{(x+a)\sqrt{x-b}} = \frac{\pi}{\sqrt{a+b}} \quad \text{(11)}\]

   (c) Prove that:\n   \[\beta(p+1, q) + \beta(p, q+1) = \beta(p, q) \quad \text{(6)}\]

   (ii) \[\int_0^\infty x^4 e^{-x^2} \, dx = \frac{3}{8}\sqrt{\pi} \quad \text{(6)}\]

8. (a) Find the area of the loop of the curve \( x(x^2 + y^2) = a(x^2 - y^2) \).
   
   (b) Find the volume generated by the revolution of the area bounded by the curve
   \[\left( \frac{x}{a} \right)^{\frac{3}{2}} + \left( \frac{y}{b} \right)^{\frac{3}{2}} = 1 \text{ about } OX. \quad \text{(12)}\]

   (c) Find the area of the surface of revolution formed by revolving the curve \( r = 2a \cos \theta \)
   about the initial line.

\[= 2 =\]
SECTION - A

1. (a) Test the continuity of the function \( f(z) = \begin{cases} \frac{(z)^2}{z} & \text{at } z = 0, \\ 0 & \text{at } z = 0. \end{cases} \)

Then show that \( f(z) \) satisfies Cauchy-Riemann equations at \( z = 0 \) but \( f(0) \) does not exist. (10)

(b) Find where the function \( f(z) = |z|^2 \) is differentiable and decide whether the function is analytic or not. (5)

(c) Show that \( u(x, y) = x^3 - 3x^2y \) is a harmonic function. Find an analytic function \( f(z) = u(x, y) + iv(x, y) \) and express \( f(z) \) in terms of \( z \). (10)

(d) Find all roots of the equation \( \cosh z = -2 \), by equating the real and imaginary parts. (10)

2. (a) Show that the integral \( \oint_C (z^2 + 3z)\,dz \) is independent of the path from \( -2 - 2i \) to the point \( 2 + 2i \) and hence evaluate it. (10)

(b) Evaluate the integral \( \oint_C |z|^2\,dz \) from \( z = 1 + i \) to \( z = 2 + 4i \), where the contour \( C \) is (i) the curve \( y = x^2 \) (ii) the line \( y = 3x - 2 \). (15)

(c) Find the image of the infinite strip \( 0 < y < \frac{2}{2} \) under the transformation \( w = \frac{1}{z} \). Also sketch the strip and its image. (10)

3. (a) Express the function \( f(z) = \frac{z}{z^2 + 1} \) in \( z \)

(i) Taylor series expansion in powers of \( (z - 1) \), stating the region of convergence. (11)

(ii) Laurent series expansion in powers of \( (z - i) \) and state the region of convergence. (12)

(b) Use Cauchy's integral formula to evaluate \( \int_C \frac{z + 3}{z(z^2 + 4)^2}\,dz \), where \( C \) is the circle \( |z - i| = 4 \), taken counterclockwise. (12)

4. Find the singular points of the following functions and classify them. Hence evaluate the integral \( \oint_C f(z)\,dz \) in each case using Cauchy's residue theorem, where \( C \) is the circle \( |z| = 3 \) taken in positive sense.

Contd .......... P/2
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Contd... Q. No. 4

(i) \( f(z) = z^5 \exp\left(\frac{1}{z^2}\right) \)  
(ii) \( f(z) = \frac{1 - \cosh z}{z^2} \)  
(iii) \( f(z) = \frac{\log z}{(z^2 + 1)^2} \)

SECTION - B

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

5. (a) By vector method find the perpendicular distance of a corner of a unit cube from a diagonal not passing through it.

(b) Give the condition of co-planarity of four points. If \( \mathbf{a}, \mathbf{b}, \mathbf{c} \) are non-co-planar vectors then prove that the following four points are co-planar:

\[
6\mathbf{a} - 4\mathbf{b} + 10\mathbf{c}, -5\mathbf{a} + 3\mathbf{b} - 10\mathbf{c}, 4\mathbf{a} - 6\mathbf{b} - 10\mathbf{c} \text{ and } 2\mathbf{b} + 10\mathbf{c}
\]

(c) Solve the vector equation for \( \mathbf{x} \):

\[
\mathbf{a} \times \mathbf{x} + (\mathbf{a} \times \mathbf{b}) \mathbf{a} + \mathbf{b} = 0 \text{ where } \mathbf{a}, \mathbf{b} \text{ are two given vectors.}
\]

6. (a) Find the equation of the binormal at any point \( \mathbf{r} \) of the curve \( x = 3 \cos t, y = 3 \sin t, z = 4t \).

(b) If \( \mathbf{r} = xi + yj + zk \) and \( \mathbf{r} = ||\mathbf{r}|| \), prove that \( \text{div} \left( \frac{\mathbf{r}(\mathbf{r})}{r} \right) = \frac{1}{r^2} \frac{d}{dr} \left( r^2 \mathbf{f}(\mathbf{r}) \right) \).

(c) If \( \mathbf{v} = \frac{x}{x^2 + y^2} \mathbf{i} + \frac{y}{x^2 + y^2} \mathbf{j} \), show that \( \int \mathbf{v} \cdot d\mathbf{r} = 0 \) for every closed path that does not include the origin. What is the value of the integral over the circle \( x^2 + y^2 = 1 \)?

7. (a) Determine whether the vector field \( \mathbf{F} = 3x^2\mathbf{y} + (x^3 + 2yz) \mathbf{j} + y^2 \mathbf{k} \) can be derived from a scalar potential or a vector potential. Then find its potential.

(b) Show that Green's theorem in plane is a special case of Stoke's theorem and verify Green's theorem in plane for \( \int (3x^2 + 2y)dx - (x + 3 \cos y)dy \) around the parallelogram having vertices at \( (0, 0), (2, 0), (3, 1) \) and \( (1, 1) \).

8. (a) Evaluate \( \iint_S \mathbf{A} \cdot d\mathbf{S} \) where \( \mathbf{A} = \mathbf{y} + 2\mathbf{x} - 3\mathbf{k} \) and \( S \) is the surface of the plane \( 2x + y = 6 \) in the first octant cut off by the plane \( z = 4 \).

(b) By converting the surface integral into a volume integral, evaluate \( \iiint_S (x^2 \, dydz + y^3 \, dzdx + z^3 \, dx) \) where \( S \) is the surface of the sphere \( x^2 + y^2 + z^2 = 1 \).
1. (a) What will be the output of the following code snippet? Why

```c
x = 1;
if (x = 8)
    printf("x equals 8\n");
else
    printf("x does not equal \n");
```

(b) Write a single statement equivalent to the following code segment using conditional operator only. You cannot use any other additional variables; however, you may use the conditional operator as many times as needed.

```c
if(a > b)
    if(a > c) max = a;
    else max = c;
else
    if(b > c) max = b;
    else max = c;
```

(c) Body Mass Index (BMI) is a measure of health on weight. It can be calculated by taking your weight in kilograms and dividing it by the square of your height in meters. The interpretation of BMI for people 16 years or older is as follows:

<table>
<thead>
<tr>
<th>BMI</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>below 16</td>
<td>Seriously underweight</td>
</tr>
<tr>
<td>16 - 18</td>
<td>Underweight</td>
</tr>
<tr>
<td>&gt;18 - 24</td>
<td>Normal weight</td>
</tr>
<tr>
<td>&gt;24 - 29</td>
<td>Overweight</td>
</tr>
<tr>
<td>&gt;29 - 35</td>
<td>Seriously overweight</td>
</tr>
<tr>
<td>above 35</td>
<td>Gravely overweight</td>
</tr>
</tbody>
</table>

Write down a C program that prompts the user to enter a weight in kilograms and height in meters and display the BMI along with its interpretation.

(d) Write down a C program that will find and determine the largest prime factor of a positive number n (>1) given as input by the user. The following table shows some of the sample runs:

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
</tr>
</tbody>
</table>

Contd ........... P/2
2. (a) Given the following C program:
```c
#include <stdio.h>

int main(void)
{
    int N = 6;
    int i, j;
    for (i = 1; i <= N + 1; i++)
    {
        for (j = 1; j <= N; j++)
        {
            printf("%c", 'A' + (i + j - 2) % N);
        }

        printf("\n");
    }

    return 0;
}
```

What is the output from an execution of the above C program?

(b) The number 153 has the property that it is equal to the sum of the cubes of its digits:

\[1^3 + 5^3 + 3^3 = 153\]

Write a complete C program that will find and print all the three-digit positive numbers that have the above property.

(c) Write down a C program that will print the smallest non-negative difference between values of a set of integers stored in an array. The number of elements in the array will be exactly 10 and all integers will be given as input. For example, for the input set \{3, 13, 20, 10, 100, 150, 175, 190, 75, 60\} the program should print the value 3 (13 and 10 are closest).

3. (a) An \(n\) by \(n\) symmetric matrix is a matrix in which the entry in row \(i\) and column \(j\) is the same as the entry in row \(j\) and column \(i\) for all pairs \(i\) and \(j\) with \(1 \leq i \leq n\) and \(1 \leq j \leq n\). For example, the matrix

\[
\begin{bmatrix}
1 & 2 & -1 \\
2 & 0 & -2 \\
-1 & 2 & 3
\end{bmatrix}
\]

is a symmetric matrix, while the matrix

\[
\begin{bmatrix}
3 & 2 & 7 \\
9 & 0 & -2 \\
1 & 2 & 3
\end{bmatrix}
\]

is not symmetric.

Write a C program that reads a 3 by 3 matrix from user determines whether or not the matrix is symmetric.

(b) Write a program in C that finds the point in a set of points that is farthest from the geometric center of the set of points. The geometric center of a set of points is a point whose \(x\) and \(y\) coordinates are the average of the \(x\) and \(y\) coordinates of the individual points. To represent the points in your program you must use the following structure:
struct point {
    float x;
    float y;
};

The coordinates of the points will be provided as input to your program. You have to store those points in an array of point structure and find the farthest point for the geometric center.

4. (a) A student has written the following function to rotate the values of 3 double variables. When x is 1.0, y is 5.0 and z is 3.5, the student wants the function call rotate3Nums(x, y, z) to change the values of x, y and z to be 5.0, 3.5 and 1.0, respectively. As written, the function call does not produce the correct result. Fix the errors in the function. You are not allowed to use pointers but you may use references. After fixing the errors, how would you call rotate3Nums function to rotate x, y and z from main function.

```c
void rotate3Nums (double num1, double num2, double num3) {
    num1 = num2;
    num2 = num3;
    num3 = num1;
}
```

(b) Suppose we have a data file that stores students' ID and four class test (CT) marks. So we have five columns in each row. We would like to write a program to divide the students' records into two groups based on their average CT marks.

- If a students' CT average is equal or greater than 30, then we will print his/her ID and all CR marks into pass.txt file;
- Otherwise, we will print his/her ID and all CT marks into fail.txt file.

For instance, your program should process the following input.txt and generate the corresponding pass.txt and fail.txt files (file contents are shown inside rectangles below):

```
ID   CT1  CT2  CT3  CT4
1    18   20   1    19
2    10   8    9    1
3    5    10   14   36
4    3    5    12   3
5    12   18   15   6
```

Write down a C program that reads input.txt and generates pass.txt and fail.txt files as described above.

(c) What is the difference between static and non-static members in C++? Give example.
5. (a) In the following macro, the intention is to produce the square of the parameter. Do you think the macro is written correctly? Justify your answer with examples. If you think the macro is not properly written, then write it down correctly.

```
#define square(x) (x"x)
```

(b) Consider the following code. The function `doubleGlobalX()` updates the value of `x` to `2*x`, and returns the value to the caller. The intention of macro "abs" is to produce the absolute value of its parameter. What will be the output of this program when user inputs -5 and 5 respectively? Explain your answer.

```
#include <stdio.h>
#define abs(x) (x < 0 ? -x : x)
int x;
int doubleGlobalX()
{
    x *= 2;
    return x;
}
int main()
{
    scanf("%d", &x);
    printf("%d
", abs(doubleGlobalX()));
    return 0;
}
```

(c) In C, the type `char` is 8 bits. It is possible to hold small integer values (in the range -128 to +127) in a variable of char type. Let `x` and `y` are 2 (signed) char variables. They are respectively initialized with values 83 and -108. Write down the following

(i) bit pattern (binary representation) stored in `x`.
(ii) bit pattern (binary representation) stored in `y`.
(iii) bit pattern of `(x & y)`
(iv) bit pattern of `(x | y)`
(v) bit pattern of `(x ^ y)`
(vi) decimal value of `-x` and
(vii) decimal value of `-y`.

6. (a) Write a recursive function that returns the sum of digits in an integer. You cannot write any loops in this function. The prototype of the function should be as follows:

```
int DigitSum(int x);
```

Here are some example values of `x` and the corresponding return value from the function:
If `x` is 320, the function should return 5. If `x` is 12, the function should return 3. If `x` is -25 the function should return 7, and so on.
(b) Implement a function called *slrSlr* that returns a pointer to the first occurrence of a search string in a string. You cannot use any library functions in your solution. Also, you cannot use array indexing in your implementation. Use pointers instead. The prototype of the function should be as follows:

```
char* slrSlr(char *str, char *strSearch)
```

Where,

*str* is the null-terminated string, within which we are looking for occurrence of a given substring.

*strSearch* is the null-terminated substring that we are searching for.

The return value from the function should be a pointer to the first occurrence of *strSearch* in *str*, or NULL if *strSearch* does not appear in *str*. If *strSearch* points to a string of zero length, the function returns *str*.

Here are some example values of *str*, *strSearch* and the corresponding return value from the function:

- `strstr("abcdefghi", "def")` returns a pointer to "defghi".
- `strstr("abababa", "baba")` returns a pointer to "bababa"
- `strstr("ubcdefg", ")")` returns a pointer to "abcdefg"
- `strstr("abcdef", "pqr")` returns NULL

(c) "By default C uses call by value to pass arguments" – Explain with an example.

7. (a) Take a look at the function prototype below. Each prototype is annotated with comments explaining what the function should do, its parameters and its return value. Implement each of these functions. (Note that, you must use dynamic memory allocation/de-allocation. You can either use new/delete operators or malloc/free methods for memory allocation/de-allocation.)

```
// Dynamically allocates memory to store the integer elements of a 2d matrix
// Parameters:
// r - the number of rows in the matrix
// c - the number of columns in the matrix
//
// Return value:
// A pointer to pointer to integer, that can be used to access
// the allocated matrix
int** AllocMatrix(int r, int c);
```

```
// De-allocates memory of a 2d matrix
// Parameters:
// pMat - A pointer to pointer to integer, that can be used to access
// the matrix
// r - the number of rows in the matrix
// c - the number of column in the matrix
void FreeMatrix(int **pMat, int r, int c);
```
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//Reads elements of a 2d matrix as follows:
//1. Scans 2 integers from console. These integers represent
// row and column size of the matrix, respectively.
//2. Allocates memory to store the integer elements of a 2d matrix
// (by calling AllocMatrix method)
//3. Scans (from console) integer elements of the matrix
// in row by row order and stores them in the allocated memory.

// Parameters:
// pRow - pointer to an integer. The pointer integer should be
// set to the row size of the matrix
// pCol - pointer to an integer. The pointer integer should be
// set to the column size of the matrix

// Return value:
// A pointer to pointer to integer, that can be used to access
// the allocated matrix

int** ReadMatrix(int *pRow, int *pCol);

(b) Write a program to check whether a string is a palindrome or not. Print "Palindrome"
if the input string is a palindrome, otherwise print "Not a palindrome". A palindrome is a
sequence of characters which reads the same backward or forward. For example, "mom",
"dad", "madam" etc. are palindromes; "mommy", "daddy", "miss" etc. are not palindromes. You will first read and integer from console that represents the size of the
input string. Then read the string. The string does not contain any spaces. You must
dynamically allocate memory to store the string. After your computations are done, you
must de-allocate the memory. You can either use new/delete operators or malloc/free
methods for memory allocation/de-allocation.

(c) Are there any errors in the following code? If so, then re-write the code correctly.
#include <stdio.h>
int main()
{
    int *pX;
    scanf("%d", &pX);
    printf("You entered %d\n", *pX);
    return 0;
}

8. A vector is 2d space can be represented by an ordered group of 3 real numbers. These 3
numbers represent its strength along x, y and z axes respectively. For example, the vector
(2, 3, -5) has 2 units strength along x-axis, 3 units along y-axis and 5 unit along the z-axis
in negative direction. Following are some operations that can be performed on vectors: (10*3+5=35)
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List U represents the vector \((u_1, u_2, u_3)\), and \(V\) represents the vector \((v_1, v_2, v_3)\). Then,

- The result of adding vector \(U\) and vector \(V\) is a vector \((u_1 + v_1, u_2 + v_2, u_3 + v_3)\)
- Subtracting vector \(V\) from vector \(U\) results in a vector \((u_1 - v_1, u_2 - v_2, u_3 - v_3)\)
- Dot product of vectors \(U\) and \(V\) is the real number \(u_1v_1 + u_2v_2 + u_3v_3\)
- Cross product of vectors \(U\) and \(V\) is a vector \((u_2v_3 - u_3v_2, u_3v_1 - u_1v_3, u_1v_2 - u_2v_1)\)
- The magnitude of vector \(U\) is the real number \(\sqrt{u_1^2 + u_2^2 + u_3^2}\)

You need to implement a class called Vector that supports the above mentioned functionalities. Store the strength of the vector along x, y and z axis in 3 private double variables called x, y and z respectively. Write appropriate constructors, overload necessary operators and implement necessary methods so that the following code in the main function works perfectly with your class. (Carefully review the code and comments therein to find out what needs to be implemented in your class.)

Do you need to implement copy constructor and assignment operator in this problem? Explain why/why not.

```cpp
int main()
{
    int i;
    double a, b, c;
    Vector vector[6];
    Vector zero(0, 0, 0);
    Vector result;
    for (i = 0; i < 6; i++)
    {
        cin >> a >> b >> c;
        // Sets the strength of vector[i] along x, y and z axes
        // to a, b, c respectively.
        vector[i].Set(a, b, c);
        if (vector[i] == zero)
        {
            cout << "You entered a zero vector" << endl;
        }
        else
        {
            // prints the magnitude of vector[i]
            cout << "You entered a vector of"
            << vector[i].Magnitude() << " magnitude" << endl;
        }
    }

    result = vector[0] + vector[1];
    cout << "Result of adding of 1st and 2nd vector is:"
    return 0;
}
```

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// Prints the vector as "(u1, u2, u3)", where u1, u2, u3
// are respectively the strength of the vector along x, y, z axes

result.Print();
result = vector[2] - vector[3];
cout << "Result of subtracting of 4th vector from 3rd vector is:";
result.Print();

Result = vector[4] * vector[5];
cout << "Cross product of 5th and 6th vector is:";
result.Print();

Cout << "Dot product of 5th and 6th vector is:
<< vector[4].Dot(vector[5]);

return 0;
}