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

Symbols have their usual meaning. Reasonably assume any missing data.

1. (a) Fig. for Q. No. 1(a) illustrates a person using an exercise machine. Points A and B correspond to the shoulder and elbow joints, respectively. Relative to the person, the upper arm (AB) is extended toward the left (x direction) and the lower arm (BC) is extended forward (z direction). At this instant the person is holding a handle that is connected by a cable to a suspending weight. The weight applies an upward (in the y direction) force with magnitude F on the arm at point C. The lengths of the upper arm and lower arm are AB = 25 cm and BC = 30 cm, respectively, and the weight weighs 20 kg. Explain how force F can be translated to the shoulder joint at point A, and determine the magnitudes and directions of moments developed at the lower and upper arms by F.  

   (15)

(b) During a practice, a shot-putter puts the shot at a distance \( l = 6 \) m. At the instant the athlete releases the shot, the elevation of the shot is \( h_0 = 1.8 \) m as measured from the ground level, and the angle of release is \( \theta = 30^\circ \) (Fig. for Q. No.1(b)). Determine the speed at which the athlete released the shot, the landing speed of the shot, and the total time the shot was in the air.

   (15)

(c) The moment of inertia of a person with 70 kg mass and 1.70 m height about the longitudinal principal axis with the person’s arms along the body is 1.0 kg.m\(^2\).

   (i) Determine the radius of gyration about the longitudinal principal axis.

   (ii) Suppose that an equivalent geometric model to this person is a cylinder of 70 kg mass and 1.70 m height. Find the radius of this cylinder.

   (5)

2. (a) Consider the traction device and a mechanical model of the leg shown in Fig. for Q. No. 2(a). The leg is held in the position shown by two weights that are connected to the leg via two cables. The combined weight of the leg and the cast is \( W = 300 \) N. \( l \) is the horizontal distance between points A and B where the cables are attached to the leg. Point C is the center of gravity of the leg including the cast which is located at a distance two-thirds of \( l \) as measured from point A. The angle cable 2 makes with the horizontal is measured as \( \beta = 45^\circ \)

   (15)

Contd .......... P/2
BME 201

Contd ... Q. No. 1

Determine the tensions $T_1$ and $T_2$ in the cables, weights $W_1$ and $W_2$, and angle $\alpha$ that cable 1 makes with the horizontal, so that the leg remains in equilibrium at the position shown.

(b) Consider that the diver of Fig. for Q. No. 2(b) has a mass of 60 kg and a radius of gyration $k = 0.45$ m about the main transverse axis. The force of reaction from the springboard on the diver has a magnitude of 600 N and its lever arm $d = 0.15$ m. The force of reaction acts 0.5 s during the jump. Determine the angular momentum introduced on the diver as well as the angular velocity with which the diver leaves the springboard.

(c) The segment forearm-hand weighing 15 N with an additional weight of 50 N on the hand, at 25 cm from the elbow, is maintained at 45° with the humerus oriented vertically, as shown in Fig. for Q. No. 2(c). The center of gravity of the forearm-hand is located at 15 cm from the articular center of the elbow, and the flexor muscle is located at 3 cm from the articular center. Determine the intensity of the flexor muscle force to maintain this position and classify the type of lever.

3. (a) Assume that the center of gravity of the gymnast as shown in Fig. for Q. No. 3(a) is located at a distance $r = 1$ m from the high bar, the speed of the center of gravity at position 1 is almost zero, and that the effects of air resistance are negligible. Position 1 is directly above the high bar and it represents the highest elevation reached by the center of gravity of the gymnast. Positions 2 and 4 make an angle $\theta = 45^\circ$ with the horizontal, position 3 is along the same horizontal line as the high bar, and position 5 is directly under the high bar. For positions 2, 4 and 5,

(i) Calculate the speeds of the gymnast's center of gravity.
(ii) Calculate the angular velocities of the gymnast.
(iii) Calculate the normal component of the linear accelerations of the gymnast's center of gravity.
(iv) Calculate the forces applied on gymnast's arms.
(v) Calculate the tangential component of the linear accelerations of the gymnast's center of gravity.
(vi) Calculate the angular accelerations of the gymnast.

(b) Why do sprint runners tilt their bodies forward at the start of a race?

4. (a) Consider the leg shown in Fig. for Q. No. 4(a), which is flexed to a right angle. The coordinates of the centers of gravity of the leg between the hip and knee joints (upper leg), the knee and ankle joints, and the foot, as measured from the floor level directly in
BME 201

Contd... Q. No. 4

(6)

line with the hip joint and the weights of the segments of the leg as percentages of the total weight \( W \) of the person are provided. Determine the location of the center of gravity of the entire leg.

(b) The man shown in Fig. for Q. No. 4(b) has a weight of 80 kg, and the coefficient of static friction between his shoes and the floor is \( \mu = 0.5 \). The horizontal separation of his center of Gravity and the center of shoe pressure is \( d \). Determine where he should position his center of gravity \( G \) at \( d \) in order to exert the maximum horizontal force on the door. What is the force?

(9)

(c) Fig. for Q. No. 4(c) illustrates a bone specimen with a circular cross-section. Two sections \( A \) and \( B \), that are \( l_0 = 6 \) mm distance apart are marked on the specimen. The radius of the specimen in the region between \( A \) and \( B \) is \( r_0 = 1 \) mm. This specimen was subjected to a series of uniaxial tension tests until fracture by gradually increasing the magnitude of the applied force and measuring corresponding deformations. As a result of these tests, the data in table below were recorded. If record 3 corresponds to the end of the linearly elastic region and record 5 corresponds to fracture point, carry out the following:

(i) Calculate average tensile stresses and strains for each record.
(ii) Draw the tensile stress-strain diagram for the bone specimen.
(iii) Calculate the elastic modulus, \( E \), of the bone specimen.
(iv) What is the ultimate strength of the bone specimen?
(v) What is the yield strength of the bone specimen? (use the offset method)

(20)

SECTION – B

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

5. (a) Draw the stress vs time graphs of elastic material, viscous materials, viscoelastic solid and viscoelastic liquid during stress relaxation test.

(b) A woman of 60 kg mass jumps with stiff legs from a table of 1 m height onto a hard floor tile. During the collision, a deceleration to a state of rest occurs in a time interval of 0.005 s. Calculate:

(i) the average force exerted on each foot by the floor and
(ii) the distance traveled by the body during the collision.

(c) As shown in Fig. 5(c), the standard solid model is composed of a spring and a Kelvin-Voight solid connected in series. The standard solid model is a three parameter \((E_1, E_2, \text{ and } \eta)\) model and is used to describe the viscoelastic behavior of a number of biological materials such as the cartilage and the white blood cell membrane. Prove that,
BME 201

Contd... Q. No. 5

\[(E_1 + E_2) \dot{\sigma} + \eta \frac{d\sigma}{dt} = E_1 \dot{E}_2 \epsilon + E_3 \eta \frac{d\epsilon}{dt}\]  

6. (a) With the help of sliding filament model, describe how muscles contract.  
(b) Name the forces acting in and on the knee during flexion.  
(c) Consider a person with 65 kg mass standing erect on her or his right foot. The mass of each set thigh-leg-foot is of 9.5 kg. Use Fig. 6(c) and determine the intensities:  
   (i) of the hip abductor muscle force \( F \), exerted by the gluteus muscle which makes an angle of 70° to the horizontal on the great trochanter of the femur, and  
   (ii) of the contact (reaction) force \( C \), exerted by the acetabulum (socket of the pelvis) on the femur head, as well as the direction of the contact force in relation to the horizontal.  

7. (a) With a schematic, describe the working principle of micropipette aspiration.  
(b) Fig. 7(b) shows the free body diagram of forearm, showing forces resulting from muscle insertions \( (T_i, i = 1 \ldots 4) \), the two components of the joint reaction forces at the elbow \( (JRF_x \text{ and } JRF_y) \), and the supported weight \( (W) \). The indices 1-4 refer to the biceps, brachialis, brachioradialis, and extensor carpi radialis longus muscles, respectively. Table 7(b) shows the value of respective forces at muscle insertions, angle that muscle makes with respect to the horizontal and distance from the elbow. Consider the value of the weight \( W \) is 120 N and it acts at 31 cm from the elbow. Draw the shear force and bending moment diagrams of the forearm.  

8. (a) Draw the kinematic data such as velocity, center of position, ground reaction force and acceleration, with respect to time observed during the crouch and push off phases of a vertical jump.  
(b) A pole vaulter with a mass of 60 kg is running with a speed of 10 m/s while running down the runway. Find the net maximum elevation of the vaulter’s center of gravity. Mention the assumptions you have made to solve the problem.  
(c) Walking is a complex superposition of five separate motions. Name those five motions. Describe the effects of pelvic rotation during walking.
Fig for Q 7 (b)

Table for Q 7 (b)

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Force at muscle insertions, $T_i$ (N)</th>
<th>Angle that the muscle makes with respect to the horizontal, $\theta$ (°)</th>
<th>Distance from elbow (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps</td>
<td>245</td>
<td>76</td>
<td>8</td>
</tr>
<tr>
<td>Brachialis</td>
<td>261</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>60</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>Extensor carpi radialis longus</td>
<td>70</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>
1. (a) With suitable diagram derive the \( i_D - v_{DS} \) characteristics of an nMOSFET for different regions considering channel length modulation and draw the \( i_D - v_{GS} \) characteristics of the nMOSFET operating in saturation region.

(b) For the circuit in Fig. for Q. 1(b) find the value of \( R \) that results in \( V_D = 0.8 \) \( V \). The MOSFET has \( V_m = 0.5 \) \( V \), \( \mu_c \), \( C_{ox} = 0.4 \) \( m^2/V^2 \), \( W = 0.72 \mu m \) and \( L = 0.18 \mu m \) and \( \lambda = 0 \). At this condition find the value \( R_2 \) that results in \( Q_2 \) operating at the edge of saturation region.

\[ V_{DD} = 1.8 \text{ V} \]

\[ \text{Fig. for Q. 1(b)} \]

2. (a) The NMOS transistor in the CS amplifier shown in Fig. for Q. 2(a) has \( V_t = 0.7 \) \( V \) and \( V_d = 50 \) \( V \). (i) Neglecting the Early effect, verify that the MOSFET is operating in saturation with \( I_D = 0.5 mA \) and \( V_{os} = 0.3 \) \( V \). What must the MOSFET’s \( k_n \) be? What is the dc voltage at the drain?

(ii) Considering channel length modulation find \( R_m \) and \( G_m \).

(iii) If \( v_{sg} \) is a sinusoid with a peak amplitude \( v_{sg} \), find the maximum allowable value of \( v_{sg} \) for which the transistor remains in saturation. What is the corresponding amplitude of the output voltage? Consider channel length modulation.

\[ \text{Fig. for Q. 2(a)} \]

Contd ........... P/2
(b) With suitable diagram explain the voltage transfer characteristics of CMOS circuit and show how the noise margin of CMOS is determined from voltage transfer curve.

3. (a) For the circuits in Fig. for Q. 3(a), find values for the labeled node voltages and all branch currents. Assume Si transistor and $\beta_{active} = 100$.

(b) Analyze the circuit in Fig. for Q. 3(b) and determine the voltages of the labeled nodes and current through all branches. Assume Si transistor with $\beta = 100$.

4. (a) In the circuit of Fig. for 4(a) $v_{dp}$ is a small sine wave signal with zero average. The Si transistor has $\beta = 100$ and early voltage $V_A = 50 \text{ V}$

(i) Find the value $R_E$ to establish a dc emitter current of $0.5 \text{ mA}$.
(ii) Find $R_E$ to establish a dc collector voltage of $+1 \text{ V}$.
(iii) Determine input resistance, output resistance and overall voltage gain of the amplifier.
(b) Draw the voltage transfer characteristics of a common emitter amplifier

SECTION – B

There are FOUR questions in this Section. Answer any THREE questions.
Make necessary assumptions.

5. (a) For the circuit shown in Fig. for Q. 5(a) find rms value of the current through diode $i_D$ and duty cycle of current waveform. Also find PIV that appears across the diode. Assume the diode is non-ideal.

(b) Design a circuit that has the transfer characteristics as shown in Fig. for Q. 5(b). Assume you have ideal diodes, resistors and DC voltage sources.

6. (a) For the circuit shown in Fig. for Q. 6(a), both diodes are identical, conducting 10 mA at 0.7 V and 100 mA at 0.8 V. Find the value of $R$ for which $v = 160$ mV.
(b) Design a Full wave rectifier for a DC load that draws 0.1 A current at a 10 V DC output voltage. Given that the supply voltage is 220 sin (2π × 50 t). For your design you need to consider the followings: (i) Supply voltage is needed to be stepped down at a suitable value using transformer. (ii) Output voltage ripple should not be more than 5%. (20)

7. (a) For the circuit shown in Fig. for Q. 7(a), find I. (10)

(b) Design a circuit using ideal Op-Amps and other necessary elements that has input voltage $V_{in} = 5 \sin (1000 t - 45^\circ)$ and output voltage $V_o = 5 \sin (1000 t + 45^\circ)$ (10)

(c) Design a circuit using ideal Op-Amps that can multiply two signals. For two input signals $V_1$ and $V_2$, output $V_o = V_1 \cdot V_2$ (15)

8. (a) Design and explain the working principle of a smoke detector circuit using OpAmp. (10)

(b) Design a source follower circuit. Why a source follower circuit is important? (8)

(c) Write the characteristics of an ideal OpAmp. (7)

(d) Explain how an integrator can smoothen a signal while a differentiator can generate spikes in a signal. (10)
SECTION – A

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

1. (a) Find the differential equation of all circles. (13)
   (b) Solve the following differential equations:
   
   \[(i) \left( \frac{x + y - a}{x + y - b} \right) \frac{dy}{dx} = \left( \frac{x + y + a}{x + y + b} \right) \]  (11)
   \[(ii) (x^2 + 2xy - y^2)dx + (y^2 + 2xy - x^2)dy = 0 \]  (11)

2. (a) What is an integrating factor? Find the integrating factor and then solve
   \[x(x - 1) \frac{dy}{dx} - y = x^2 (x - 1)^2 \]  (12)
   (b) Solve the following differential equations:
   
   \[(i) x \frac{dy}{dx} + y = y^2 \ln x \]  (12)
   \[(ii) (y^4 + 2y)dx + (xy^3 + 2y^4 - 4x)dy = 0 \]  (11)

3. (a) Solve the differential equation \[\frac{d^2y}{dx^2} + a^2y = \frac{a^2R}{p}(l - x)\] subject to the conditions
   \[y = 0 \text{ and } \frac{dy}{dx} = 0 \text{ at } x = 0, \text{ where } a, R, p, l \text{ are constants.} \]  (11)
   (b) Solve the following differential equations:
   
   \[(i) (D^4 + 2D^2 + 1)y = x^2 \cos x \]  (12)
   \[(ii) (x^2D^2 - 2xD + 2)y = x^2 + \sin(5\ln x) \]  (12)

4. (a) Solve the following differential equations:
   
   \[(i) x \left( \frac{d^2y}{dx^2} + x \left( \frac{dy}{dx} \right)^2 \right) - \frac{dy}{dx} = 0 \]  (11)
   \[(ii) y \left( \frac{d^2y}{dx^2} + \left( \frac{dy}{dx} \right)^2 \right) = y^2 \]  (11)
   (b) Solve the following differential equation by the method of factorization of operator
   \[3x^2 \frac{d^2y}{dx^2} + \left( 2 + 6x - 6x^2 \right) \frac{dy}{dx} - 4y = 0 \]  (13)

Contd .......... P/2
MATH 213/BME

SECTION – B

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

5. (a) Define singular points. Find the series solution of the following differential equation by using the method of Frobenius:

\[
2x^2 \frac{d^2 y}{dx^2} - x \frac{dy}{dx} + (x - 5)y = 0
\]

(b) Form a partial differential equation by eliminating the arbitrary function \( \phi \) from

\[
\phi(x - y + z, x^2 - 3y^2 + z^2) = 0.
\]

6. (a) Find the integral surface of the partial differential equation

\[(x - y)p + (y - x - z)q = z \text{ which passes through the circle } z = 1, x^2 + y^2 = 1.\]

(b) Define Charpit’s Method. Using Charpit’s method find the complete integral of the partial differential equation

\[pxy + pq + qy - yz = 0.\]

(c) Find the complete and singular integrals of the following partial differential equation:

\[(p^2 + q^2)y = qz\]

7. Solve the following higher order partial differential equations:

(a) \[\left(D_x^2 - 2D_xD_y - 15D_y^2\right)z = xy\]

(b) \[\left(D_x^2 - D_xD_y - 2D_y^2 + 2D_x + 2D_y\right)z = e^{3x+4y} + \cos(2x + y)\]

(c) \[\left(3D_x^2 - 2D_y^2 + D_x - 1\right)z = 4e^{x+y} \sin(x + y)\]

8. (a) Solve the following higher order partial differential equation:

\[\left(x^2D_x^2 - xyD_xD_y - 2y^2D_y^2 + xD_x - 2yD_y\right)z = \log\left(\frac{y}{x}\right) - \frac{1}{2}\]

(b) Solve the wave equation

\[\frac{\partial^2 u}{\partial t^2} = a^2 \frac{\partial^2 u}{\partial x^2}\]

under the condition: \( u = 0 \) when \( x = 0 \) and \( x = \pi \)

\[\frac{\partial u}{\partial t} = 0 \text{ when } t = 0 \text{ and } u(x, 0) = x, 0 < x < \pi.\]

Hence explain your solution physically for the above wave equation.
SECTION – A

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

1. (a) Given two unsorted arrays A and B with length m and n respectively, write down the following two functions:
   i. `void union (int A[], int B[], int C[], int m, int n)` to implement \( C = A \cup B \), and
   ii. `void intersect (int A[], int B[], int D[], int m, int n)` to implement \( D = A \cap B \).

As an example, suppose \( A = \{7, 1, 5, 2, 3, 6, 1\} \) and \( B = \{3, 8, 6, 20, 7, 8\} \). Then \( C = \{7, 1, 5, 2, 3, 6, 8, 20\} \) \( D = \{7, 3, 6\} \).

(b) What is meant by the "scope of a variable"? Describe the variety of scopes with proper examples.

(c) Write down a whole C program that will take an English letter in upper case as input and will print the letter two steps ahead of it in the alphabet in lowercase. For Example, if the user enters D, the output will be F. If the input is Z, the output will be b. You are not allowed to use any if-else, switch-case or ternary operator to solve the problem.

2. (a) Write down a C function that will return the index of the first occurrence of a substring in a string. The string and substring will be passed as the first and the second argument of the function respectively. You must write down your C function using pointer and avoiding array. The prototype of the function is as follows:

   ```c
   int findSubStrIndex (const char *str, const char *substr);
   ```

For example findSubStrIndex ("This is a pen.", "is") will return 2, while findSubStrIndex ("This is a pen.", "ball") will return -1.

(b) Write a whole C program that will repeatedly read 2 integers, \( p \) and \( q \) until both are 0. For every \( p \) and \( q \), print their product.

(c) Discuss about the problems in the following code segment.

```c
#include<stdio.h>
int main()
{
    int a;
    int diff;
    int *q;
    double *p;
    a = 10;
    p=&a;
    *p=100;
    
    Contd ........ P/2
```
3. (a) A number is called \textbf{sparse} if there are no two adjacent 1's in its binary representation. 
For example 5 (binary representation: 101) is sparse, but 6 (binary representation: 110) is not. Write a C function \textbf{int isSparse(int x)} that takes an integer \(x\) and returns 1 if \(x\) is sparse, and returns 0 otherwise. 

(b) Write down a C function \textbf{int bitParity (int x)} that takes an integer \(x\) as parameter and returns 1 if there is odd number of 0's in the binary representation of \(x\), and returns 0 otherwise. 

(c) Write a whole C program that takes as input an integer \(x\) and prints \textbf{yes} if \(x\) is a sparse number with odd parity, otherwise prints \textbf{no}. Hint: use the functions in 3(a) and 3(b). 

4. (a) A magic square is a square matrix of distinct numbers (each number is used only once), where the numbers in each row, and the number is each column, and the numbers in each diagonal, all add up to the same number. For example, the following is a magic square where the numbers in each row, and in each column, and in each diagonal and up to 15.

\[
\begin{array}{ccc}
6 & 1 & 8 \\
7 & 5 & 3 \\
2 & 9 & 4 \\
\end{array}
\]

Write a C function \textbf{isMagicSquare(int n, int A[][n])} that checks whether the given square matrix \(A\) with \(n\) rows is magic square or not. If the matrix is a magic square, then the function will return 1, otherwise 0. You do not need to write the main function.

(b) For any positive integer \(n\), the \(n\)-th number of the following series is given as:

\[f(n) = 1, \text{if } n = 0 \]
\[f(n) = n \times f(n-1) + n, \text{otherwise}\]

So, the first 6 numbers in the series are:

\[1, 2, 6, 21, 88, 445\]

Write down a function \textbf{checkInTheSeries(int x)} which returns 1, if the parameter \(x\) is in the series and returns 0 otherwise. For example, checkInTheSeries(1) should return 1, checkInTheSeries(88) should return 1, but checkInTheSeries(50) should return 0.
CSE 281/BME

SECTION – B

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

5. (a) Write the general form to define an enumeration. Show how to create an enumeration of the colors (Violet, Indigo, Blue, Green, Yellow, Orange and Red) contained in the rainbow. Declare rb_color as a variable of this type of enumeration. State two uses of enumerations. \(4 + 4 + 2 + 2.5 \times 2 = 15\)

(b) What is a bit-field? Why is it useful? Can the address of a bit-field variable be obtained? Justify. \(3 + 3 + 5 = 11\)

(c) Write the output of the following C program.
\[
\text{#include <stdio.h>}
\text{#define cubic(x) (x)*(x)*(x)}
\text{#define mcubic(x) x * x * x}
\text{#define rcubic(x) (x * x * x)}
\]

\[
\text{void main()}
\{
\text{int a = 3, b = 2, c = 2;}
\text{c = rcubic (c+1)*3;}
\text{a = mcubic (a+1)*3;}
\text{b = cubic (b+1)*3;}
\text{printf ("%d\n\%d\n\%d\n", a, b, c);}
\}
\]

6. (a) Show how to make Dbl a new name for double and declare a variable named height using Dbl. \(3 + 2 = 5\)

(b) What are the common defining traits of all object Oriented Programming Languages? \(3 \times 1.5 = 4.5\)

(c) Write the two ways to cause a function to be expanded in-line with examples. Mention two advantages of using in-line functions rather than parameterized macros.

What are the restrictions that apply to in-line functions? \(4 \times 2 + 3 \times 2 + 4 \times 1.5 = 20\)

(d) Assume that the class derived1 directly inherits two classes base1 and base2, whereas the class derived2 directly inherits two classes base3 and base4. If the class derived3 directly inherits derived1 and derived2, down the inheritance graph. \(5.5\)

7. (a) class sample {
\[
\text{public: int x, y;}
\]

\[
\text{void fn(sample *a, int *px)}
\{
\text{*px = a->x;}
\text{a->x = a->y;}
\text{a->y = *px;}
\}
\]

Now rewrite the above function fn using reference parameters instead of pointer parameters.

Contd .......... P/4
(b) Using default arguments and avoiding function overloading, rewrite the following overloaded function test so that the functionality of test is preserved.

```c
int test(int a, int b)
{  return a * b;  }

int test(int a)
{  return a*a;  }
```

(c) #include <string.h>
```c
class test {
  char *p;
public:
  test (char *r)
  {  
    p = new char [strlen(r) + 1];
    strcpy(p, r);
  }
  ~test() { delete[] p; }
...
};
```

```c
void main()
{  
  test a("Hi"), b("Hello");
  test c = b;
  a = b;
  ...  
  ...  
}
```

Now point out and eliminate the problem(s) in the above C++ program if any. You are not allowed to modify the main function and the destructor of the class test.

8. (a) What is a friend function? Can a friend function be friend with more than one class?

Can a friend function have a this pointer?

```
(3+2+2=7)
```

(b) class point {
```c
int x, y;
public:
  point(int a, int b)
  {  
    x = a;
    y = b;
  }
```
```
};
```

For the class point, define a friend function that takes two parameters of type point and returns the distance between two points. Using the defined function and two instances of the class point, write codes to calculate the distance between (1, 2) and (2, -5).

Contd .......... P/5
(c) What potential problem might exist when multiple base classes are directly inherited by a derived class. How can this problem be eliminated? (5+3=8)

(d) Write the output of the following C++ Program.

```cpp
#include <iostream.h>

class sample{
  int i;
public:
  set_i(int a) { i = a; }
  int get() { return i * i; }
  ~sample() { cout << "Destroying object\n"; }
};

void main() {
  sample *q;
  q = new sample[3];
  for (int i = 0; i < 3; i++) {
    q[i].set_i(i+2);
    cout << q[i].get() << "\n";
  }
  delete []q;
}
```
1. (a) Define demand function.  \( (5) \)
   (b) What are the factors that influence the shifting of the demand curve?  \( (10) \)
   (c) How would you derive the market demand curve of a commodity? Explain graphically.  \( (10) \)
   (d) What are the main determinations of supply?  \( (10) \)

2. (a) What are the determinants of price elasticity of demand? Explain them.  \( (10) \)
   (b) Show that price elasticity of demand varies from zero to infinity along any straight line demand curve. There are two parallel straight line demand curves. Show that the curve which is nearer to the origin has a higher price elasticity of demand at any point. Explain graphically.  \( (15) \)
   (c) From the following table calculate elasticity of demand if you move from point A to C and explain what you understand from the result.  \( (10) \)

<table>
<thead>
<tr>
<th>POINT</th>
<th>( P_x )</th>
<th>( Q_y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td>B</td>
<td>600</td>
<td>150</td>
</tr>
<tr>
<td>C</td>
<td>700</td>
<td>180</td>
</tr>
</tbody>
</table>

3. (a) What is an indifference curve? Explain the properties of an indifference curve.  \( (15) \)
   (b) Explain consumer’s equilibrium with the help of budget line and indifference curve.  \( (10) \)
   (c) From the following budget line and the utility function, calculate the amount of two commodities that maximizes satisfaction. What is the maximum amount of satisfaction?

\[
4000 = 25X + 35Y \\
U = 400X^{0.6}Y^{0.7}
\]

4. (a) How is price determined in an economy under competition? What will happen to the price and quantity due to simultaneous change in demand and supply?  \( (15) \)
   (b) From the following demand and supply functions, calculate equilibrium price and quantity and show the result in a graph.

\[
P = 0.1Q + 8 \\
P = -0.5Q + 50
\]

Contd .......... P/2
HUM 241
Contd ... Q. No. 4(b)

(i) Plot the new demand function \( P' = -0.6Q + 36 \) on the graph and calculate new equilibrium price and quantity.

(ii) Describe the change in equilibrium. Show the equilibrium coordinates on the same graph.

(iii) What will happen to the equilibrium price and quantity if government imposes a unit tax of Tk 2 per unit?

(iv) What will happen if government gives a subsidy of Tk. 3 per unit?

(v) Describe the change in equilibrium after imposition of taxes. Show the equilibrium coordinates on the same graph.

SECTION – B

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

5. (a) Using a typical size distribution of personal income, show how ‘Kuznets ratio’ and ‘Gini coefficient’ are measured. Why is inequality among those above the poverty line a matter of big concern? Discuss. (20)

(b) Critically evaluate the miraculous economic development of China. What lessons can Bangladesh learn from Chinese experience? (15)

6. (a) Explain the fundamental economic problems that every economy has to face. How are these problems addressed in different types of economic systems? (20)

(b) Distinguish between ‘project evaluation’ and ‘cost-benefit analysis’ with examples. Briefly describe the procedure of a cost-benefit analysis (CBA). (15)

7. (a) When does a firm emerge as a monopolist? What are the conditions for equilibrium of a firm under monopoly? Illustrate the short run equilibrium of a firm under monopoly. (20)

(b) Describe the relationship between marginal revenue (MR), price (P) and price elasticity of demand (e) under monopoly. (15)

8. Write short notes on any THREE of the following: (35)

(a) Three core values of development
(b) The Neocolonial Dependence Model
(c) Law of diminishing marginal utility
(d) The neoclassical counterrevolution.