## Bangladesh Army University of Science and Technology
### Department of Civil Engineering
Final Examination, Winter 2022

Course Code: MATH 1109         Level-1    Term-I

Time: 03 (Three) hours         Full Marks:180

**Course Title: Math I (Differential Calculus, Integral Calculus and Coordinate Geometry)**

N.B
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course outcomes (COs) are given in the right most column.

### PART- A (Marks: 90)

(Answer any three questions from 1 to 4 including Q. No. 1)

|  |  |  | Marks | COs |
|---|---|---|---|---|
| 1. | a) | Define limit of a function. | 05 | 1 |
|  | b) | Prove that if $\lim_{x \to a} f(x)$ exist, then it must be unique. | 10 | 1 |
|  | c) | Test the continuity and differentiability of the function $$f(x) = \begin{cases} 2x - 1 & if\ 0 < x \leq 1 \\ x^2 - x + 1 & if\ x > 1 \end{cases}$$ at the point $x = 1$. | 15 | 2 |
| 2. | a) | Find $y_n$ in the case of $y = \frac{1}{(ax+b)^m}$. | 10 | 2 |
|  | b) | State Leibnitz's Theorem. | 05 | 1 |
|  | c) | If $y = e^{a \sin^{-1} x}$ then prove that $(1 - x^2)y_2 - a^2 y = 0$. Hence prove that $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} - (n^2 + a^2)y_n = 0$. | 15 | 2 |
| 3. | a) | State Role's Theorem. | 05 | 2 |
|  | b) | Verify Rolle's Theorem for $f(x) = x^2 + 5x - 6$ in the interval $(-6, 1)$. | 10 | 1 |
|  | c) | If $v = \sin^{-1} \frac{x^2+y^2}{x+y}$ then show that $x\frac{\partial v}{\partial x} + y\frac{\partial v}{\partial y} = \tan v$ | 15 | 2 |
| 4. | a) | The cost of manufacturing a certain article is given by the formula $f(x) = 2x^3 - 15x^2 + 36x + 12$. Find maximum and minimum cost. | 15 | 3 |
|  | b) | Find the radius of curvature at the point $(x, y)$ on the curve $y = a \log \left\{sec \left(\frac{x}{a}\right)\right\}$. | 15 | 2 |

(Answer any three questions from 5 to 8 including Q. No. 5)

|  |  |  | Marks | COs |
|---|---|---|---|---|

5. a) Integrate:  15  3

   (i) $\int_{-\infty}^{\infty} \frac{1}{1+x^2} dx$    (ii) $\int \frac{\sin \sqrt{x}}{\sqrt{x}} dx$    (iii) $\int e^x \sin x \, dx.$

   b) Find the reduction formula for $\int \sin^n x \, dx.$   15  3

6. a) Define Beta function and show that, $\beta(m,n) = \beta(n,m).$   20  3

   b) Using Wallis formula, find the value of $\int_0^{\pi/2} \sin^9 x \, dx.$   10  3

7. a) Find the entire area within the cardioid $r = 4(1 + \cos\theta).$   15  4

   b) Derive the formula for the circumference of a circle of radius $r.$   15  4

8. a) Find the radical center of the circles $x^2 + y^2 - 2x + 4y - 3 = 0,$   10  4
   $x^2 + y^2 + 4x - 3y - 5 = 0,$ and $x^2 + y^2 - x - y + 1 = 0.$

   b) Determine the shortest distance between the skew lines   20  4

   $$L_1: \quad x = 1 + 2t, \quad y = 1 - 4t, \quad z = 2 + 4t$$

   $$L_2: \quad x = 2 - 5t, \quad y = 4 - 3t, \quad z = 5 - t.$$

## Bangladesh Army University of Science and Technology
### Department of Civil Engineering
Final Examination, Winter 2022

Course Code: CHEM 1109  
Time: 03 (Three) hours

Level-1    Term-I  
Full Marks:180

**Course Title: Chemistry**

N.B
- Figures in the margin indicate full marks allotted to each question.
- Symbols and abbreviations bear their standard meaning.
- Use separate answer script for each PART.
- The corresponding course outcomes (COs) are given in the right most column.

### PART- A (Marks: 90)

(Answer any three questions from 1 to 4 including Q. No. 1)

|  |  |  | Marks | COs |
|---|---|---|---|---|
| 1. | a) | Describe Bhors Atom Model with its limitations. | 10 | 1 |
|  | b) | Explain why the 19th electron of potassium enter into 4s instead of 3d. | 10 | 1 |
|  | c) | State the Pauli's exclusion principle with example. | 10 | 1 |
| 2. | a) | Write down modern periodic law. Find out the position of the following elements in the periodic table using electronic configuration- (i) Calcium    (ii) Iron (iii) Phosphorous | 15 | i |
|  | b) | List down the characteristics of a good paint. | 10 | 4 |
|  | c) | Write the name of some paints. | 05 | 4 |
| 3. | a) | Describe manufacturing of cement with flow diagram. | 15 | 4 |
|  | b) | Explain briefly the stages of setting of cement with reactions. | 15 | 4 |
| 4. | a) | What is thermoplastic and thermosetting plastic? Write down their advantages and disadvantages. | 20 | 4 |
|  | b) | Briefly explain surface pretreatment. | 10 | 4 |

(Answer any three questions from 5 to 8 including Q. No. 5)

| | | | Marks | COs |
|---|---|---|---|---|
| 5. | a) | Define Kp. Establish a relation between Kp and Kc. | 15 | 2 |
| | b) | Using the equation of Kp prove that, amount of product increase with increasing the pressure for the following reversible reaction: | 15 | 3 |

$$N_2(g) + H_2(g) \rightleftharpoons NH_3(g)$$

| | | | Marks | COs |
|---|---|---|---|---|
| 6. | a) | Define order of reaction. Deduce the integrated rate equation of a second order reaction. | 15 | 2 |
| | b) | What is half-life of a reaction? Prove that half-life of a first order reaction does not depend on the initial concentration of reactants. | 15 | 2 |
| 7. | a) | What do you mean by boiling point of a liquid and enthalpy of vaporization? | 15 | 2 |
| | b) | Explain the term degradation of polymer. Describe three processes of degradation of polymers. | 15 | 2 |
| 8. | a) | Describe Clausius-Clapeyron equation. | 15 | 4 |
| | b) | Write short notes on- (i) Capillary action (ii) Viscosity (iii) Surface tension | 15 | 4 |

Course Code: PHY 1109                                      Level-1      Term-I
Time: 03 (Three) hours                                   Full Marks:180

**Course Title: Physics I**

N.B • Figures in the margin indicate full marks allotted to each question.
• Symbols and abbreviations bear their standard meaning.
• Use separate answer script for each PART.
• The corresponding course outcomes (COs) are given in the right most column.

## PART- A (Marks: 90)

(Answer any three questions from 1 to 4 including Q. No. 1)

|   |   |   | Marks | COs |
|---|---|---|---|---|
| 1. | a) | Define damped harmonic motion. | 05 | 1 |
|  | b) | Find an expression for the differential equation of damped harmonic oscillation. | 20 | 2 |
|  | c) | The equation for displacement of a point on a damped oscillator is given by, $x = 5e^{-0.25t} \sin\frac{\pi}{2}t$ meter. Find the velocity of the oscillating point at $t = \frac{T}{4}$. | 05 | 3 |
| 2. | a) | Explain mechanical waves. | 05 | 1 |
|  | b) | Derive the differential equation of a particle executing simple harmonic oscillation and hence show that $y = a \sin(\omega t + \phi)$. | 20 | 2 |
|  | c) | Show that the time period of a simple pendulum will be infinite kept in a falling left. | 05 | 3 |
| 3. | a) | Define potential energy and kinetic energy. | 06 | 1 |
|  | b) | Prove that total energy of a simple harmonic osciliator does not depend upon time and it is constant. | 18 | 2 |
|  | c) | A body is vibrating with simple harmonic motion of amplitude 15 cm and frequency 4 Hz. Calculate: i) the maximum values of the acceleration and velocity and ii) the acceleration and velocity when the displacement is 9 cm. | 06 | 3 |
| 4. | a) | Write down the postulates of the kinetic theory of gases. | 05 | 1 |
|  | b) | Show that pressure of a gas is two-third of the kinetic energy per unit volume of the gas. | 20 | 2 |
|  | c) | Calculate the root mean square velocity of a molecule of mercury vapour at 300 K. | 05 | 3 |

(Answer any three questions from 5 to 8 including Q. No. 5)

| | | | Marks | COs |
|---|---|---|---|---|
| 5. | a) | Write down the conditions in which real gas behaves like an ideal gas. | 05 | 1 |
| | b) | Show that the average kinetic energy per molecule of a perfect gas per degree of freedom is $\frac{1}{2}kT$. | 15 | 2 |
| | c) | Calculate the molecular diameter of Nitrogen molecules, if $n = 2.7 \times 10^{25}$ molecules per m³ and mean free path for nitrogen is $8 \times 10^{-8}$ m. | 10 | 3 |
| 6. | a) | What is meant by thermodynamic equilibrium? | 05 | 1 |
| | b) | Obtain an expression for the efficiency of a reversible Carnot engine with a perfect gas as the working substance. | 15 | 2 |
| | c) | The Van der Waals constants $a$ and $b$ for 1 gram molecule of Hydrogen are $a = 0.245$ atms-litre²-mole$^{-2}$ and $b = 2.67 \times 10^{-2}$ litre-mole$^{-1}$. Calculate the critical temperature. | 10 | 3 |
| 7. | a) | Define stream line motion and turbulent motion of a fluid. | 05 | 1 |
| | b) | Derive an expression for surface tension of liquid by capillary rising method. | 15 | 2 |
| | c) | Calculate the terminal velocity of an air bubble of radius $2 \times 10^{-5}$m rising in a water of viscosity $10^{-3}$Ns/m. Density of water is $10^{3}$kg/m³. [Neglect density of air in comparison to that of water]. | 10 | 3 |
| 8. | a) | Explain the terms: stress and strain. | 05 | 1 |
| | b) | Show that the maximum possible value of Poisson's ratio is 1/2. | 15 | 2 |
| | c) | Find the force required to increase the length of a steel wire of $10^{-6}$ m² area of cross-section by 50% whose Young's modulus is $2 \times 10^{11}$ Nm$^{-2}$. | 10 | 3 |

# Bangladesh Army University of Science and Technology
## Department of Civil Engineering
### Final Examination, Winter 2022

Course Code: CE 1103

Time: 03 (Three) hours

Level-1    Term-I

Full Marks: 180

**Course Title: Surveying**

N.B. • The questions are of equal value.
• Figures in the margin indicate full marks allotted to each question.
• Symbols and abbreviations bear their standard meaning.
• Use separate answer script for each PART.
• The corresponding course outcomes (CLOs) are given in the right most column.

## PART- A (Marks: 90)

(Answer any three questions including Q. No. 1)

Marks   CLOs

1. a) Illustrate the types of levelling operations with neat sketches.    (12)    1

   b) The profile of a longitudinal levelling is shown in Fig. 1 below.    (18)    3
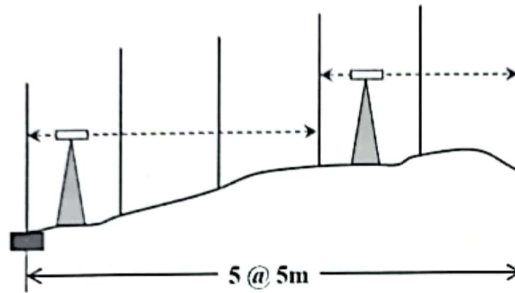


Fig. 1

The consecutive readings taken from a dumpy level at every 5 m interval are:

2.850,  1.950,  1.125,  0.700,  2.525,  2.260,  2.525 m

The first reading was taken at a chainage of 70 m where the value of RL (Reduced Level) is 101.100 m. The instrument was shifted after fourth reading.

Apply any of the following two methods to determine the values of RL (Reduced Level) at respective points:

   i.   Line of collimation method
        or,
   ii.  Rise-and-fall method

2. a) Illustrate, with neat sketch, the process (any five) of taking perpendicular offset on field.    (10)    1

   b) Fig. 2 shows the plot of the main campus of BAUST. It was prepared few years back on the basis of data collected from a chain survey. The scale used for this map was 40 m to 1 cm. But most recently, it is found that the map has been shrunk and a line originally 20 cm long is only 19.5 cm long at present. Again the 20 m chain was 3 cm too long. If the present area of the map measured by a planimeter is 27.20 cm², determine the true area of the land surveyed.    (20)    2
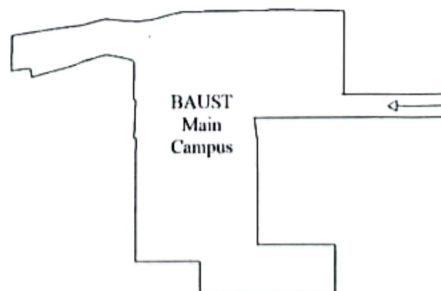


BAUST Main Campus

Fig. 2

3. a) Describe the process of orientation in plane table survey with sketches.    (10)    1

   b) Describe any five characteristics of contour line with proper figures.    (10)    1

   c) Briefly explain the process of reciprocal ranging with neat sketch.    (10)    1

4. a) Explain any two of the following terms with neat sketches:     (10)   1
    - i. Index sketch
    - ii. Double line field book
    - iii. Bench mark

   b) The following forward and backward bearings were observed in a closed traverse:     (20)   2

| Line | Length (m) | Fore Bearing | Back Bearing |
|------|-----------|--------------|--------------|
| AB | 30 | $43^{0}22'$ | $223^{0}25'$ |
| BC | 35 | $34^{0}32'$ | $214^{0}40'$ |
| CD | 33 | $101^{0}20'$ | $281^{0}20'$ |
| DA | 34 | $218^{0}46'$ | $38^{0}40'$ |

   Draw the closed traverse ABCDA on the basis of the date given below and calculate the interior angles ($\angle A$, $\angle B$, $\angle C$, $\angle D$).

### PART- B (Marks: 90)

(Answer any three questions including Q. No. 5)

                                                    Marks   CLOs

5. a) Define centrifugal ratio (CR). What are allowable values of centrifugal ratio (CR) for roads and highway?     (5)   1

   b) In saidpur bypass road intersection, two tangents intersect at chainage 1,260 m. The angle of intersection is 150°. Calculate all data necessary for setting out a curve of radius 240 m by the deflection angle method. The peg intervals may be taken as 20 m. Prepare a setting out table when the least count of the vernier is 20". Also calculate the data for field checking.     (25)   2

6. a) Explain celestial latitude and longitude system.     (10)   1

   b) Describe earth's orbital motion round the sun with necessary illustration and relate them with seasons.     (20)   2

7. a) Illustrate Geographic Information System (GIS) with applications.     (10)   1

   b) The following offsets are taken from a survey line to a curved boundary line:     (20)   2

| Distance (m) | 0 | 4 | 8 | 12 | 16 | 24 | 32 | 44 | 56 |
|--------------|------|------|------|------|------|------|------|------|------|
| Offset (m) | 2.70 | 4.80 | 3.23 | 4.55 | 5.67 | 5.40 | 5.80 | 4.50 | 3.40 |

   Find the area between the survey line, the curved boundary line, and the first and the last offsets by:
   - i. The trapezoidal rule
   - ii. Simpson's rule.

8. a) Briefly describe any two of the followings with neat sketches (if any):     (10)   1
    - i. Transition curve
    - ii. Spherical triangle
    - iii. Prismoidal formula for volume computation
    - iv. Remote sensing

   b) A road embankment of BAUST central field road of formation width of 8 m and side slope 2:1 is to be constructed. The ground level along the centre line is as follows:     (20)   3

| Distance (m) | 0 | 50 | 100 | 150 | 200 | 250 |
|--------------|--------|--------|--------|--------|--------|--------|
| Offset (m) | 115.75 | 114.35 | 116.80 | 115.20 | 118.50 | 118.25 |

   The embankment has a rising gradient of 1 in 100, and the formation level at zero chainage is 115.00. Assuming the ground is level across the centre line, compute the volume of earth work.