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MCH–014

MASTER OF SCIENCE IN

CHEMISTRY/MASTER OF SCIENCE IN

ANALYTICAL CHEMISTRY

(MSCCHEM/MSCANCHEM)

Term-End Examination

December, 2025

MCH-014 : MATHEMATICS FOR CHEMISTS

Time : 1 Hour *Maximum Marks : 25*

Note : *(i) Attempt any* ***five*** *questions.*

(ii) Usual notations are used.

(iii) Use of calculator is not allowed.

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1. (a) For $X = \{x, y, z, v, w\}$, $A = \{x, y\}$ and $B = \{y, z, w\}$, verify the De Morgan's law for the sets A and B. 3

   (b) Verify whether

   $$dz = (51x^2y + 47y^4)\,dx + (17x^3 + 188xy^3)\,dy$$

   is an exact differential or not. 2

2. (a) Prove that the points A (1, – 2, 3), B (2, 0, 4) and C (1, 2, 1) form a right-angled triangle. 3

   (b) Calculate the sum of the following series upto twenty terms : 2

   $$(-3) + (-1) + 1 + 3 + 5 + \ldots\ldots\ldots$$

3. Wave functions of a particle in a one-dimensional box of length a and infinite height is given as :

   $$\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right);\ n = 1, 2, 3, \ldots\ldots$$

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Show that the wave functions for $n = 1$ and $n = 2$ are orthogonal. 5

[**Hint :** for orthogonal condition

$$\int_0^a \psi_m^*(x)\, \psi_n(x)\, dx = 0]$$

4. (a) Find the maximum value of the function $f(x) = x^3 - 3x$. 3

(b) If ${}^nP_r = 3024$ and ${}^nC_r = 126$, find the value of r. 2

5. (a) The extent of dissociation of PCl_5 at a certain temperature is 20% at 1.0 atm. pressure. Calculate the value of the equilibrium constant, K_p. 3

(b) Show that the function $z = \dfrac{x^2 + y^2}{x^3 + y^3}$ is homogeneous function. 2

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6. Write the differential rate equation for the following first order reaction :

$$A \xrightarrow{k} B$$

(i) Solve this rate equation to get integrated rate equation. Plot a schematic graph between t and $\frac{[A]}{[A]_0}$, where $[A]_0$ = initial concentration of A

[A] = concentration of A at time 't' and t = time 4

(ii) Derive the expression for half life of the above reaction. 1

7. Solve the following set of equations, using the matrix method : 5

$$x + 3y + 2z = 6$$

$$-x + 4y + 5z = 8$$

$$2x + 5y + 3z = 10$$

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8. (a) Define Binomial distribution and write the terms in the binomial expansion. 2

(b) For a diabetes patient, the following levels of blood glucose are found at different times : 3

S. No.	Time	Glucose level (in g/L)
1	6 : 00 A.M.	1.013
2	7 : 00 A.M.	1.108
3	8 : 00 A.M.	1.201
4	9 : 00 A.M.	1.115
5	10 : 00 A.M.	1.075

Calculate the 95% confidence interval of the data at $\sigma = 0.018$ g/L. [Given : the limit at 95% confidence level

$$= \pm \frac{1.96\,\sigma}{\sqrt{7}}\ ]$$

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