


Name:			
Enrolment No:			
<b>UPES</b> <b>End Semester Examination, December 2024</b>			
<b>Course: Fundamentals of Group theory</b> <b>Program: B.Sc. (H) Chemistry by Research</b> <b>Course Code: CHEM4012</b>		<b>Semester: VII</b> <b>Time : 03 hrs.</b> <b>Max. Marks: 100</b>	
<b>Instructions:</b> <ol style="list-style-type: none"> <li>Write your enrolment number on the top left of the question paper.</li> <li>Do not write anything else on the question paper except your enrolment number.</li> <li>Attempt all parts of a question at one place only.</li> <li>Internal choice is given for question number 9 of Section B and question number 11 of Section C only.</li> <li>Use Character Table wherever required.</li> </ol>			
<b>SECTION A</b> <b>(5Qx4M=20Marks)</b>			
S. No.		Marks	CO
Q 1	Discuss postulates of the Great orthogonality theorem.	4	CO1
Q 2	Determine $\Gamma_{3N}$ for the following molecules: (a) H <sub>2</sub> O (C <sub>2v</sub> )      (b) POCl <sub>3</sub> (C <sub>3v</sub> )	4	CO2
Q 3	Assign the point group of the following compounds: (a) BrF <sub>5</sub> (b) SO <sub>2</sub>	4	CO2
Q 4	Elaborate different types of symmetry elements present in XeF <sub>4</sub> .	4	CO3
Q 5	Explain the following with examples: (i) Plane of symmetry (ii) Centre of symmetry	4	CO1
<b>SECTION B</b> <b>(4Qx10M= 40 Marks)</b>			
Q 6	Mention the irreducible components of the following reducible representations (use the character tables): (a) D <sub>3d</sub> (b) C <sub>4v</sub>	10	CO3
Q 7	Deduce the matrix representation for the identity rotational operation and reflectional operation, rotational–reflectional operation and inversion.	10	CO3
Q 8	Elaborate all the forbidden transition in D <sub>4h</sub> and C <sub>4v</sub> .	10	CO4

Q 9	Construct the character table for $C_{3v}$ point group.  <b>OR</b> How are the irreducible representation symbolized? Write the reduction formula. Also, explain two examples for irreducible representation?	<b>10</b>	<b>CO3</b>
<b>SECTION-C</b> <b>(2Qx20M=40 Marks)</b>			
Q 10	(a) Explain IR and Raman active mode in $CH_4$ . (b) Consider an octahedral molecule $XY_6$ whose point group is $O_h$ . Prove the irreducible representation of $O_h$ is $\Gamma = A_{1g} + E_g + T_{1u}$ .	<b>10+ 10</b>	<b>CO4</b>
Q 11	(a) Explain elements of symmetry and symmetry operations. (b) Find the irreducible components of the representations generated by a set of five d-orbitals in environments of $T_d$ . <b>OR</b> Construct SALCs corresponding to bond stretches, and in- and out-of-plane bending modes for $NH_3$ ( $C_{3v}$ ).	<b>20</b>	<b>CO3</b>