Seat No. : _____

ME-130

March-2022

M.Sc., Sem.- I

401 : Chemistry

(Inorganic Chemistry)

Time : 2 Hours] **[Max. Marks : 50**

Note : (1) Answer any **three** questions from Section – I

(2) Section – II is **compulsory**.

Section – I

1. (A) Prove that "the projection operator is idempotent". Show that a projection operator has only two eigen values. **7**

   (B) The ground state of Hydrogen atom has the Eigen function $\psi = e^{-ar}$. Normalise this function and find out the normalisation constant. **7**

2. (A) Find out the commutator value for the Angular momentum operators Lx and Ly. **7**

   (B) Apply the first order correction to the eigen value in the perturbation theory to the helium atom and prove that E = - 2.75 a.u. **7**

3. (A) Apply the 'Similarity transformation' to NH_3 molecule and prove that C_3^1 and C_3^2 belong to same class. **7**

   (B) Taking wave function as the basis for NH_3 molecule, prepare 2×2 matrices for the different symmetry operations. **7**

4. (A) Find out the direct product for $T_2 \times T_1$ in Td point group. **7**

(B) Discuss the different areas of the character table. **7**

5. (A) Discuss in detail transition metal-alkene compounds. **7**

(B) Write a note on activation of small organic molecules by organo-metallic compounds (Discuss any four). **7**

6. (A) Discuss the stability of Metal-Carbon bond in organometallic compounds. **7**

(B) Write a note on transition metal-cyclopentadienyl complexes. **7**

7. (A) Explain the splitting of d-orbitals in square planar, trigonal-bi-pyramid and trigonal prismatic complexes. **7**

(B) Discuss (a) the effect of metal on splitting of d-orbital and (b) Use of Magnetic moment to deduce the structure of $[Fe(H_2O)_6]^{+3}$; $\mu s = 5.91$ B.M. **7**

8. (A) Describe important features of ligand field theory, discuss & draw the diagram for octahedral complex in presence of π-donar ligand. **7**

(B) Considering example of f^2 system, explain the rules for determination of exact terms which will have symbol 1I, 3H, 3G.etc. **7**

Section – II

9. Answer the following questions in short : **8**

(1) What are the two eigen values of a projection operator ?

(2) What are the values of ladder operators of angular momentum ?

(3) Find out if the given matrix is orthogonal or not : $\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$

(4) Which of the following vectors of point group Oh are orthogonal to A_2g ?

A_1g, A_2g, Eg. and A_2U.

(5) Give the reaction for Fischer and Hafner method.

(6) Define Hapticity.

(7) Give Order of energy levels for Trigonal Bipyramidal complex.

(8) Write equation to find total microstates.

SOME USEFUL CHARACTER TABLES

C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma'_v\ (yz)$		
A_1	1	1	1	1	z	x^2, y^2, z^2
A_2	1	1	−1	−1	R_z	xy
B_1	1	−1	1	−1	x, R_y	xz
B_2	1	−1	−1	1	y, R_x	yz

C_{3v}	E	$2C_3$	$3\sigma_v$		
A_1	1	1	1	z	$x^2 + y^2, z^2$
A_2	1	1	−1	R_z	
E	2	−1	0	$(x, y)(R_x, R_y)$	$(x^2 - y^2, 2xy)(xz, yz)$

C_{2h}	E	C_2	I	σ_h		
A_g	1	1	1	1	R_z	x^2, y^2, z^2, xy
B_g	1	−1	1	−1	R_x, R_y	xz, yz
A_u	1	1	−1	−1	z	
B_u	1	−1	−1	1	x, y	

T_d	E	$8C_3$	$3C_2$	$6S_4$	$6\sigma_d$		
A_1	1	1	1	1	1		$x^2 + y^2 + z^2$
A_2	1	1	1	−1	−1		
E	2	−1	2	0	0		$(2z^2 - x^2 - y^2,\ (x^2 - y^2)$
T_1	3	0	−1	1	−1	(R_x, R_y, R_z)	
T_2	3	0	−1	−1	1	(x, y, z)	(xy, xz, yz)