Registration No :


Total Number of Pages: 01

## $5^{\text {th }}$ Semester Back Examination 2019-20 SYMMETRY AND GROUP THEORY <br> BRANCH : M.Sc.I(AC) <br> Max Marks : 70 <br> Time: 3 Hours <br> Q.CODE : HB512

Answer Question No. 1 which is compulsory and any FIVE from the rest.
The figures in the right hand margin indicate marks.
Q1 Answer the following questions:
a) Write the matrix representation for identity element.
b) What is axis of symmetry?
c) For which of the following molecule mutual exclusion principle is applicable?
$\mathrm{CH}_{4}, \mathrm{CO}_{2}$
d) Write two subgroups of $\mathrm{C}_{2 v}$ point group.
e) Differentiate between conrotatory and disrotatory.
f) What do you mean by transition moment integral?
g) To which irreducible representation does the $\mathrm{p}_{\mathrm{z}}$ orbital belong in $\mathrm{NH}_{3}$ molecule?
h) How will you know a three-dimensional representation in any point group?
i) What do you mean by a trivial group?
j) Which symmetry is retained during the thermal conversion of butadiene to cyclobutene?

Q2 a) Establish the relation between the reducible and irreducible representation for the following reducible representation.

| $\mathrm{C}_{2 v}$ | E | $\mathrm{C}_{2}$ | $\sigma_{\mathrm{xz}}$ | $\sigma_{x z}$ |
| :---: | :---: | :---: | :---: | :---: |
|  | 9 | -1 | 1 | 3 |

b) Write the mathematical expression of Great Orthogonality Theorem explaining each term.

Q3 Construct a character table for a $\mathrm{C}_{2 v}$ point group.
Q4 Construct the MO energy level diagram for an octahedral complex.
Q5 a) Determine the point group of the following:
$\mathrm{B}_{2} \mathrm{H}_{6}$, trans- butadinene, $\mathrm{CHCl}_{3},\left[\mathrm{~V}\left(\mathrm{H}_{2} \mathrm{O}\right)_{6}\right]^{3+}$ and $\mathrm{CS}_{2}$
b) What is plane of symmetry? Explain each type of it?

Q6 Find out the number of fundamental vibrational modes and their symmetry for
$\mathrm{H}_{2} \mathrm{O}$ molecule.
Q7 a) Apply the projection operators for $\mathrm{C}_{2 \mathrm{v}}$ groups on $\mathrm{p}_{\mathrm{x}}$ and $\mathrm{p}_{\mathrm{z}}$ orbitals.
b) With the help of group theory find out the atomic orbitals used for formation of hybrid orbitals for a square planar geometry.

Q8 Write short answer on any TWO :
a) Improper axis of rotation
b) Woodward-Hoffmann cyclisation rule
c) Selection rules for spectral transition

