Sr. No. of Question Paper	:		
Unique Paper Code	:	32177905	
Name of the Paper	:	DSE: Molecular Modelling and Drug Design	
Name of the Course	:	**B. Sc (Hons.) Chemistry**	
Semester	:	VI	
Duration	:	2 hours	Maximum Marks : 75

Instructions for Candidates

1. All questions carry equal marks.
2. Answer **four questions** in all.
3. First part of each question carries 0.75 marks.
4. Remaining parts of each question carry 6 marks.
5. Attempt all parts of a question together.

1. a) Koopman's theorem helps in correct prediction of _____ by relating it to the energy of Highest Occupied Molecular Orbital.
   b) Molecular Mechanics cannot predict the energy values of orbitals for any chemical system. Justify. Write the expression of a generalized force field and explain each term.
   c) The concentration of drug in water and Octanol is 0.75 M and 0.6978 M respectively. Comment on the descriptor that can be used to help in setting up Quantitative Structure Activity Relationship using the given data. How is π substituent constant related to it?
   d) (i) Construct the z-matrix using appropriate labels for water molecule. (ii) Predict the number of bond stretching terms and bond angle terms in the z matrix for a linear straight chain hydrocarbon whose slater determinant is of the order 16 X 16?

2. a) Number of cartesian coordinates – Number of internal coordinates = _____
   b) Suggest the best suited and fastest method out of the following:
   (i) Semi-empirical method (ii) Ab-initio method (iii) Molecular Mechanics Method
   for modelling a macromolecule with around 750 atoms giving appropriate reasons and highlight the salient features of the method. Write down the expression of force-field involved for carrying out the calculations.
   c) In the Extended Hückel Method, how many atomic orbital wavefunctions will the basis set of ethylene consist of? What will be the order of Fock matrix in this case? What will be the order of Fock Matrix if simple Hückel Method is used?
   d) Explain the difference between a relaxed potential energy surface and a rigid potential energy surface.

   Or

   Explain the double zeta and split valence basis sets with examples.

3. a) _____potential is involved in MD Simulations.

b) A molecule of C_4H_9OH is optimized using a method that involves assumptions or approximations to Quantum mechanical calculations and obtains some parameters from empirical data. Which method has been used? List any two types of sub-groups of the method and explain.

c) How do you account for the non-bonded interactions in a force field for Molecular Mechanics calculations? Explain

d) The energies of Highest Occupied Molecular Orbital and Lowest Unoccupied Molecular Orbital of a molecule AB are -0.3502 eV and -0.1113 eV respectively. Comment on the Ionization energy of the molecule. State the theorem involved. Why doesn't it work for calculations of electron affinities? Justify

4.a)According to Pauli's principle, the total wavefunction must be _____with respect to exchange of coordinates and spin.

b) Differentiate between IC_{50} and LD_{50}. The LD_{50} values (in mg/kg) for some chemicals A, B, C, D are: A= 35; B= 22; C = 75; D= 29. Arrange these chemicals in increasing order of their toxicity. Justify your answer.

c) Distinguish between the following pairs:

i) STOs and GTOs

ii) Ab-initio and DFT

d) Draw and compare radial distribution function (RDF) plots for solid, liquid and gas.

5. a) EHT and PPP make use of _____approximation.

b) A dynamics simulation involved is based on random sampling method. Name the method and how is it different from other simulation techniques. Explain the algorithm involved briefly.

c) Out of the given computational models; UFF, AM1, HF/STO3-G, B3LYP/6-31G* explain giving suitable reason/s which one is the most accurate way of modelling the following:

(i) proteins and nucleic acids

(ii) organic compounds containing 5-10 carbon atoms

(iii) steroids

(iv) nucleophilic behaviour of molecules

d) Construct a Gradient and Hessian Matrix for water molecule. What do the eigen values of a Hessian indicate?

6. a) In molecular modeling, steepest descent method is used for/as_____.

b) Slow temperature drifts do occur during Molecular Dynamics Simulations. Why? Suggest a suitable method for performing MD simulations at constant temperature.

c) Expand the following abbreviations and highlight important features of each of the following: (i) AMBER (ii) PM3

d) For a two electron system there are four possible spin functions:

(i) $\alpha(1)\alpha(2)$, (ii) $\alpha(1)\beta(2)$, (iii) $\alpha(2)\beta(1)$, (iv) $\beta(1)\beta(2)$

The concept of indistinguishability forces us to consider only linear combinations of 2 and 3,

$\psi_{\pm} = (1/\sqrt{2})\,[\alpha(1)\beta(2) \pm \alpha(2)\beta(1)]$

Of the four acceptable spin functions, show that three are symmetric and one is antisymmetric.

OR

Set up Slater determinant for He atom. Show that it is in exact accordance with Pauli's exclusion principle.

RT/RG/MS