COE office 29/11/24 (EVE) KMV-II

Exam Code: 224701 **Paper Code: 1212**

Master of Science (Chemistry) Semester I

Course Title: Ligand Field Theory

Course Code: MCHL-1081

Time: 3 Hours **Max. Marks: 70**

Note: Attempt five questions, selecting one question from each section. The fifth question can be attempted from any section. Each question carries 14 marks. Students are allowed to use non-programmable calculator.

SECTION-A

Q1. (a) Construct a group multiplication table for C_{3v} point group by taking ammonia as an example.

(b) How is group theory helpful in understanding σ and π bonding in octahedral complexes?

Q2. (a) What are the rules for the determination of irreducible representation of any symmetry point group?

(b) What are symmetry elements? Also find the point group for the following molecules:-

(i) C_2H_2 (ii) H_2O (iii) C_6H_6 (iv) $PtCl_4$

SECTION-B

Q3. (a) Calculate the ground state terms for the p^3, p^4, d^3 and d^8 ions using L.S. Coupling scheme.

(b) Discuss the effect of tetrahedral field on D and F terms with the help of Character table?

Q4. (a) Write down all the energy terms that are possible for a free gaseous atom having configuration (i) $3d^2 4s^2$ (ii) $2s^2 2p^1$.

(b) Discuss the σ and π bonding in tetrahedral complex by constructing molecular orbital diagram.

SECTION-C

Q5. (a) What is the quenching of orbital angular momentum and what are its consequences on the transition metal complexes.

(b) Construct an Orgel diagram for the d^1 and d^9 configuration of metal in octahedral complex.

Q6. (a) Discuss LaPorte selection rule and spin selection rule of electron absorption spectroscopy.

(b) How you evaluate strong crystal field term of d^2 configuration in tetrahedral crystal field using group theory.

SECTION-D

7. (a) Give comments on the spectra of cis and trans $[Co(en)_2X_2]^+$.

(b) What is the importance of Tanabe Sugano diagrams over orgel diagrams?

8. (a) Write a note on electronic spectra absorption spectra of low spin complexes.

(b) Give comparison between d-d bands and f-f bands in complex.

Exam Code: 224701 **Paper Code: 1213**

Master of Science (Chemistry) Semester I

Course Title: Organic Reaction Mechanism-I

Course Code: MCHL-1082

Time: 3 Hours **Max. Marks: 70**

Note: Attempt five questions, selecting one question from each section. The fifth question can be attempted from any section. Each question carries 14 marks.

SECTION-A

1. (a) Define alternant and non-alternant hydrocarbons? Explain this concept using suitable examples?

(b) Discuss PMO approach in detail using example of 1,3-butadiene ?

2. (a) Discuss different elements of symmetry? What are the conditions for a compound to be optically active? Also explain the difference between stereospecific and stereo- selective synthesis?

(b)What do you mean by resolution? Explain different methods of resolution with suitable examples.

SECTION-B

3. (a) Explain S_Ni, mixed S_N1 and S_N2 mechanism in detail along with their stereochemistry?

(b)Explain anchimeric assistance observed in organic compounds and its effect on the organic reactions with suitable examples?

4. (a) Discuss various methods to detect reactive intermediates formed in organic reactions. Also explain the methods for trapping these reaction intermediate with suitable example?

(b)Discuss various types of reaction mechanisms observed in organic synthesis. Also explain the concept of Hard acid-Soft base in detail?

Section-C

5. (a) Discuss S_E1 mechanism and also explain the effect of substrate,

leaving group and solvent polarity on the reactivity of electrophilic substitution reactions?

(b) Give detail overview of diazo transfer reaction mechanism.

6. (a) Explain in detail nucleophilic substitution reactions occurring at vinylic and aliphatic trigonal carbon.

(b) Explain rearrangements in carbocations? Also discuss Meyer's synthesis of aldehydes and ketones?

Section-D

Q7. (a) Explain reaction, mechanism and synthetic utility of Vilsmeir and Pechmann reaction in detail?

(b) Explain arenium ion mechanism along with orientation and reactivity of mono-substituted benzenes?

Q8. (a) Discuss SNAr1 and SNAr2 mechanism in detail. Also discuss how reactivity depends upon nature of substrates, leaving group and nucleophile in SNAr reactions?

(b) Explain reaction, mechanism and synthetic utility of Von Richter and Sommelet-Houser rearrangement?

Exam Code: 224701 **Paper Code: 1214**

Programme: Master of Science (Chemistry)
Semester: I
Course Title: Physical Chemistry-Thermodynamics
Course Code: MCHL-1083

Time Allowed: 3 hours **Max. Marks: 70**

Note: Students are required to attempt five questions out of eight, selecting at least one from each section. The fifth question may be attempted from any section. All questions carry equal marks. (14 each) Use of simple calculator is allowed.

Section A

1. (a) What is chemical potential? How it varies with change in pressure and temperature?

   (b) Explain the different laws of thermodynamics in detail. (7, 7)

2. (a) What is fugacity? Derive the expression to find the value of fugacity.

   (b) Define partial molar volume. Explain two methods to determine it. (7, 7)

Section B

3. (a) What is an ensemble? What physical variables are the same between members of an ensemble?

   (b) How are macrostates and microstates related? How is the Boltzmann Factor related to ensembles? (7, 7)

4. (a) Derive Boltzmann distribution law for a degenerate system. Also explain what is meant by degeneracy.

   (b) Differentiate between micro-canonical, canonical and grand canonical ensembles. (7, 7)

Section C

5. (a) What do you mean by partition function? What is the physical significance of partition function?

   (b) Derive an expression for the rotational partition function of an ideal diatomic gas. (7, 7)

6. (a) Discuss Bose-Einstein statistics and its applications to Helium.

   (b) Discuss heat capacity behaviour od solids in terms of partition functions. (7, 7)

Section D

7. (a) Prove Onsager's reciprocity relation law from the principle of microscopic reversibility.

   (b) Define the following terms: Flux, driving force and transport coefficient. (7, 7)

8. (a) Explain the coupled reactions. What is their significance in biological systems?

   (b) Write short notes on the following:

   (a) Non-equilibrium stationary states.

   (b) Electrokinetic effects. (7, 7)

Exam Code:224701 **Paper Code**:1215

Program: Master of Science (Chemistry)

(Semester I)

COURSE TITLE: Spectroscopy A: Techniques for Structure Elucidation of Organic Compounds

COURSE CODE: MCHL-1084

Time: 3hr **Max marks: 70**

Note: -- Note: Attempt five questions in all, selecting at least one question from each section. The fifth question may be attempted from any section. Non programmable calculator can be used. Each question carries 14 marks.

SECTION-A

1. (a) Explain the complete NMR spectrum of 2,5-Dimethylphenol and p-Aminophenol? (7)

   (b) Compare Continuous wave and Fourier transformation measurement techniques in NMR? (7)

2. (a) Explain the correlation of H bound to carbon, H bound to other nuclei such as nitrogen, oxygen, sulphur? (7)

   (b) Explain Karplus relationship and multipulse NMR spectroscopy? (7)

SECTION-B

3. (a) Discuss the various types of electronic transitions and explain the effect of the polarity of the solvent and conjugation on each type of transition? (7)

   (b) Write in detail various general fragmentation modes in mass spectrometry? (7)

4. (a) The wavelength as well as the extinction coefficient increases with the increase in the conjugation in the compound. Justify the statement. (7)

   (b) What do you understand by metastable peaks? How these are recognized in the mass spectrum and what is their importance? (7)

SECTION-C

5. (a) What do you mean by the number of fundamental vibrations? How will you detect the type of hydrogen bonding involved in a particular compound by Infra-red spectroscopy? (7)

   (b) Discuss in detail the various factors which influence the vibrational frequency of a particular group in Infra-red spectroscopy? (7)

6. (a) How will you determine purity of organic compounds by Infra-red spectroscopy. Also discuss at least three types of groups for which the study of finger print region is essential? (7)

(b) Discuss the laws governing IR spectroscopy and explain in detail its sampling techniques. (7)

SECTION-D

7. (a) A pale yellow compound is slightly acidic in nature and gave the following data:

UV: λ_{max} 280 mμ ε_{max} 6600.

IR: 3460 (v, sh), 3035 (m), 1608 (m), 1585 (m), 1510 (s), 1360 (s), 1320 (s), 740 (v, s).

The band at 3460 cm^{-1} does not shift even on diluting the sample.

NMR: 2.1 τ (1H, singlet); 2.61-2.75 2.15-2.8τ (4H, unsymmetrical pattern)

Determine the structure of the compound. (7)

(b) Molecular weight = 100

UV: λ_{max} 274 mμ ε_{max} 2050

IR: 3031 (v), 2941 (w), 1725 (s), 1608, 1504 (w), 1060 (s) and 830 cm^{-1} (s).

NMR: (i) 7.65τ (3H, singlet), (ii) 6.18τ (3H, singlet), (iii) 2.15-2.8τ (4H, unsymmetrical pattern)

Determine the structure of the compound. (7)

8. (a) An organic compound with molecular weight 108 s not acidic in nature but can be easily oxidized to a crystalline compound (m.pt. 122 °C). It gives the following spectral data:

UV: λ_{max} 255 mμ ε_{max} 202.

IR: 3402 (s, b), 3065 (w), 2288 (m), 1499 (w, sh) and 1455 (m).

NMR: 2.74τ (singlet, 24.5 squares); 5.4τ (singlet, 9.5 squares) and 6.10τ (singlet, 4.8 squares

Determine the structure of the compound. (7)

(b) An organic compound with molecular weight 120 absorbs in ultraviolet spectrum at 268 nm ε_{max} 480. In infra-red spectrum, medium absorption bands are formed at (i) 3067-2907 cm^{-1} (ii) 1608 cm^{-1} (m) and 1473 cm^{-1} (m). The NMR spectrum shows absorption as below:

(i) 3.21τ singlet (10.4 squares) and (ii) 7.74τ singlet (31.0 squares)

Determine the structure of the compound. (7)

Exam Code: 224701 **Paper Code: 1216**

Master of Science (Chemistry) Semester I

Course Title: Computer for Chemists

Course Code: MCHM-1135

Time: 3 Hours **Max. Marks: 20**

Note: Attempt five questions, selecting one question from each section. The fifth question can be attempted from any section. Each question carries 4 marks.

Section – A

1. Explain arithmetic operators with programming examples in C.
2. Explain algorithms and flowcharts.

Section – B

3. Explain input and output functions in C with programming examples in C.
4. Explain if else statement and nested if statement with programming examples in C.

Section – C

5. Explain ASCII code.
6. Explain the do while and while do statements with programming examples in C.

Section – D

7. Write a program in C to calculate median.
8. Explain Arrays. How they are useful?

C.O.E office 28/11/24 (EVE) KMV-II

Exam Code: 225701 **Paper Code: 1217**

Master of Science (Mathematics) Semester I

Course Title: Real Analysis

Course Code: MMSL-1331

Time: 3 Hours **Max. Marks: 70**

Note: Attempt five questions, selecting one question from each section. The fifth question can be attempted from any section. Each question carries 14 (7+7) marks.

Section-A

Q-1 (a) Define the Space R^3,and prove that it is a metric Space.

(b) Prove that the interval [0,1] is uncountable .

Q-2 (a) Prove that closure of a set is always a closed set and it is the smallest closed set containing that set.

(b) State and Prove Weierstrass theorem for R^K

Section-B

Q-3 (a) Define separated sets and prove that a set is disconnected if it is the union of two non empty separated sets

(b) Find out all the components of a discrete metric Space. Also find the component of R. Also prove that every component is closed but need not open.

Q-4 (a) Prove that a metric space is compact iff any sequence in X has a convergent subsequences. Also find the convergent sequence in a discrete metric space.

(b) Define diameter of a set along with nth tail of the sequence. Prove that diameter of closure of E is same as diam of E in metric Space (X,d).

Section-C

Q-5 (a) Define contraction mapping .Give an Example of the same and prove that contraction mapping is Uniformly continuous

(b) State and prove Banach Fixed point theorem

Q-6 (a) Show that a continuous function f of a metric space X into a metric space Y takes convergent sequences into convergent sequences. Also give an example of a function which is continuous at single point of its domain

(b) Give an example of a function which is uniformly continuous. Justify your answer. And prove that every function defined on a discrete metric space is continuous

Section-D

Q-7 (a) State and Prove W.M. test for uniform convergence of series of functions

(b) Test for uniform convergence and term by term integration of the series $\sum_{n=1}^{\infty} \frac{x}{(n+x^2)^2}$. Also prove that $\int_0^1 \left(\sum_{n=1}^{\infty} \frac{x}{(n+x^2)^2}\right) dx = \frac{1}{2}$.

Q-8 (a) Show that the sequence <fŋ> where fŋ(x) = $\frac{nx}{1+n^2x^2}$, is not uniformly convergent on any interval containing '0' by M(n) test

(b) Prove the Weierstrass Approximation Theorem

1218

Exam Code: 225701 **Paper Code: 1217**

Programme: Master of Science (Mathematics)

Semester - I

Course Title: Complex Analysis

Course Code: MMSL-1332

Time Allowed: 3 Hours **Max. Marks: 70**

Note: Attempt five questions in all, selecting atleast one question from each section. Fifth question may be attempted from any section. Each question carries 14 marks.

Section-A

1(a) Prove that $u = x^2 - y^2, v = \frac{-y}{x^2+y^2}$, then both u and v satisfy Laplace's equation, but $u + iv$ is not an analytic function of z.

(b) Define Harmonic function. Show that a harmonic function satisfies the formal differential equation $\frac{\partial^z u}{\partial z \partial \bar{z}} = 0$.

2(a) Using Cauchy's Integral formula, Calculate $\int_C \frac{e^{az}}{(z-\Pi i)} dz$, where C is the ellipse $|z-2| + |z+2| = 6$.

(b) If $u + v = \frac{2\sin 2x}{e^{2y}+e^{-2y}-2\cos 2x}$ and $f(z) = u + iv$ is analytic function of $z = x + iy$, find $f(z)$ in terms of z.

Section-B

3(a) State and prove Liouville's theorem.

(b) Show the image of the infinite strip $\frac{1}{4} \leq y \leq \frac{1}{2}$ under the transformations $w \leq \frac{1}{z}$. Also show the regions graphically.

4(a) Find the image of the circle $|z-2| = 2$ under the Mobius transformations
$w = \frac{z}{z+1}$.

(b) Find a bilinear transformation which maps the circle $|w| \le 1$ into a circle $|z-1| < 1$ and maps $w = 0$ *and* $w = 1$ respectively into $z = \frac{1}{2}$, z=0.

Section-C

5 State Taylor's theorem and Laurent's theorem and obtain the Taylor's or Laurent's series which represent the function $f(z) = \frac{1}{(1+z^2)(z+2)}$, when

$(i)\ |z| < 1 \quad (ii)\ 1 < |z| < 2 \quad (iii)\ |z| > 2$

6(a) State and prove Cauchy's Residue Theorem.

(b) Use Rouche's Theorem to show that the equation $z^5 + 15z + 1 = 0$ has one root in the disc $|z| < \frac{3}{2}$ and four roots in the annulus $\frac{3}{2} < |z| \le 2$.

Section-D

7(a) Show that $z = a$ is an isolated essential singularity of the function $\frac{e^{\frac{c}{z}-a}}{e^{\frac{c}{z}}-1}$.

(b) Show that $\int_0^{2\pi} \frac{d\theta}{2+\cos\theta} = \frac{2\pi}{\sqrt{3}}$.

8(a) Show by Contour integration that $\int_0^{\infty} \frac{1}{(1+x^2)} dx = \frac{\pi}{2}$.

(b) Show by Contour integration that
$\int_0^{\infty} \frac{\sin mx}{x} dx = \frac{\pi}{2}, \quad m > 0$.

Exam Code:225701 Paper Code: 1219

Programme: Master of Science (Mathematics)
Semester-I
Course Title: Algebra-I
Course Code: MMSL-1333

Time Allowed: 3 Hours **Maximum Marks:70**

Attempt five questions, selecting one question from each section. The fifth question may be attempted from any Section. Each question carries equal marks. (14)	Marks
Section A	
1. (a) Prove that the set of four 4^{th} root of unity form a finite abelian group of order four under ordinary multiplication as composition.	7
(b)State and prove Lagrange's theorem for finite groups.	7
2. (a) Prove that every subgroup of a cyclic group is cyclic.	5
(b) Prove that Z(G) of a group G is a normal subgroup of G.	5
(c) Determine all the generators of a cyclic group of order 28.	4
Section B	
3. (a) For a finite group G, prove that $O(G) = \sum \frac{O(G)}{O(N(a))}$ where the sum runs over one element a of each conjugate class.	7
(b) State and prove Fundamental theorem of Homomorphism.	7
4.(a) Prove that A_4 has no subgroup of order 6.	7
(b) Prove that A_n is a normal subgroup of S_n.	7
Section C	
5.(a) State and prove Sylow's second theorem.	7
(b) Every finite group has atleast one composition series.	7

6.(a) State and prove Jordan Holder theorem.	7
(b) Show that group of order 40 is not simple.	7
Section D	
7. (a) Define internal direct products.	10
(b) Show that the group Z_8 cannot be written as the direct sum of two non-trivial subgroups.	4
8. (a) Show that the direct product of two cyclic groups G and G' is a cyclic group iff $\left(O(G), O(G')\right) = 1$	7
(b) Write $Z_2 \times Z_2$. Is $Z_2 \times Z_2$ a cyclic group.	7

Exam Code: 225701 **Paper Code: 1220**

Master of Science (Mathematics) Semester I

Course Title: Mechanics - I

Course Code: MMSL-1334

Time: 3 Hours **Max. Marks: 70**

Note: Attempt five questions, selecting one question from each section. The fifth question can be attempted from any section. Each question carries 14 marks.

SECTION A

Q1) (a) An aircraft pursues a straight course with constant velocity V and is being chased by a guided missile moving with constant speed 2V and fitted with a homing device to ensure that its motion is always directed at the target. Initially the missile is at right angles to the course of the aircraft and distance R from it. Find the polar equation of the missile's pursuit curve relative to the target, taking the course of the target as the initial line $\theta = 0$, and find the time taken by it to strike the target. (9)

(b) A rigid body has a spin ω and a particle a of the body has velocity $\vec{v}$. Show that every particle P of the body with velocity vector parallel to $\vec{\omega}$ lies on the line

$$\overrightarrow{AP} \equiv \overrightarrow{(\omega \times \vec{v})} / \omega^2 + \mu \vec{\omega}$$

μ being an arbitrary scalar. (5)

Q2) (a) Prove that $\vec{\omega} = \frac{1}{2}$ Curl $\vec{v}$ (5)

(b) Discuss velocity and acceleration components in cylindrical polar coordinates. (9)

Section B

Q3) (a) Show that necessary and sufficient condition for a field of force $\vec{F}$ to be conservative is that Curl $\vec{F} = 0$ (7)

(b) State and prove Principle of Conservation of Energy. (7)

Q4) A small stone of mass m is thrown vertically upwards with initial speed V. If the air resistance at speed v is mkv^2, where k is a positive constant, show that the stone returns to its starting point with speed

$$V\left[1+\frac{kV^2}{g}\right]^{-1/2}$$

If the stone has the same mass and initial speed but if the air resistance is mkv, Show that the stone returns to its starting point with speed U given by the equation

$$g - kU = (g + Kv) \exp\{-k(U+V)/g\}$$ (14)

Section C

Q5 Discuss the motion of particle on a cycloid. (14)

Q6) (a) A particle P of mass m moving in a circle with radius 'a' and center O under a force $\mu m[r + 2a^3/r^2]$ directed towards O. If P is acted upon by an impulse tangential to the path and of magnitude $(3\mu m^2a^2)^{1/2}$. Show that the velocity of P is immediately doubled and that the greatest and least distances from O in the ensuing motion are a and 3a. (9)

(b) A particle is projected with velocity V from the cusp of a smooth inverted cycloid down the arc, show that time of reaching the vertex is

$$2\sqrt{\frac{a}{g}}\tan^{-1}\frac{\sqrt{4ag}}{V}$$ (5)

Section D

Q7) (a) A square of side 'a' has particles of mass m, 2m, 3m, 4m at its vertices. Show that the principal moments of inertia at the centre of square are $2ma^2$, $3ma^2$, $5ma^2$ .Also find the directions of principal axes. (7)

(b). Find the equation of momental ellipsoid of the rectangular block referred to the axes OX, OY, OZ where O is a corner of the rectangular block. (7)

Q8) (a) Define Principal Axes. Show that at each point of a body there are three principal axes mutually at right angles to each other such that the product of inertia about them taken two at a time is zero. (9)

(b) State and prove the theorem of parallel axes for moments of inertia. (5)

Exam Code: 225701 **Paper Code: 1221**

Programme: Master of Science (Mathematics)

Semester – I

Course Title: Differential Equations

Course Code: MMSL-1335

Time Allowed: 3 Hours **Max. Marks: 70**

Note: Attempt five questions in all, selecting at least one from each section. Fifth question may be attempted from any section. Each question carries 14 marks.

Section-A

1. State and prove Sturm's Separation theorem. **(14)**

2. (a) If $f_1(x), f_2(x)$ are two linear independent solution of $a_0y'' + a_1y' + a_2y = 0$ where $a_0 \neq 0 \; \forall \; x \in (a, b)$ then prove that $W(y_1, y_2, x) = W(y_1, y_2, x_0)\, e^{-\int \frac{a_1 t}{a_0 t} dt}$ where x_0 is point in (a,b) **(7)**

(b) Find the third approximation of $\frac{dy}{dx} = 2x + z, \; \frac{dz}{dx} = 3xy + x^2 z$ where y=2, z=0 at x=0 **(7)**

Section-B

3. (a) Prove that $L\left\{\frac{Cos\, at - Cos\, bt}{t}\right\} = \frac{1}{2}\log\frac{s^2+b^2}{s^2+a^2}$ **(7)**

(b) Evaluate $L^{-1}\left\{\frac{3s+7}{s^2-2s-3}\right\}$ **(7)**

4. (a) If $L\{F(t)\} = f(s)$ *then prove that*

$$L\{t^n F(t)\} = (-1)^n \frac{d^n}{ds^n} f(s)\ ; n = 1,2,3 \ldots..$$ (7)

(b) Solve the following differential equation using Laplace Transform $(D^2 + 4D + 8)y = 0, \quad given\ that$ $y(0) = 2, y'(0) = 2$ (7)

Section-C

5. (a) If $F(x) = Sin\ nx\ , n \in Z$. Show that $f_c(m) = \begin{cases} 0, \ if\ (n-m) is\ even \\ \frac{2n}{n^2-m^2},\ if\ (n-m) is\ odd \end{cases}$ where m= 1,2,3…. (7)

(b) Show that the Fourier transform of

$F(x) = e^{-\frac{x^2}{2}}\ is\ \sqrt{2\pi}\ e^{-\frac{p^2}{2}}$ (7)

6. (a) State and prove Convolution theorem. (7)

(b) If $f_c(p) = \frac{1}{1+p^2}\ then\ find\ F_c^{-1}\left\{\frac{1}{1+p^2}\right\}$ (7)

Section-D

7. (a) Show that $x\,J_n'(x) = n\,J_n(x) - x\,J_{n+1}(x)$ (7)

(b) State and prove orthogonality for $P_n(x)$ (7)

8. (a) Prove that $e^{2tx-t^2} = \sum_{n=0}^{\infty} \frac{t^n}{n!} H_n(x)$ (7)

(b) Prove that

$(n+1)L_{n+1}(x) = (2n+1-x)L_n(x) - n\,L_{n-1}(x)$ (7)