**Exam Code: 508601** **Paper Code: 1204**

**Programme: Master of Science (Physics) FYIP**

**(Semester – I)**

**Course Title: Mechanics**

**Course Code: FPHL-1393**

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

**Note: Attempt five question 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. For planar motion of a particle, find expression for its velocity and acceleration in plane polar co-ordinates. (14)
2. Define solid angle and prove that homogeneity of space leads to the conservation of linear momentum. (14)

**Section B**

3. Explain the laboratory and centre of mass systems. Discuss the elastic and inelastic collision in centre of mass frame. (14)
4. Derive Euler's equations of rotation about a fixed axis. (14)

**Section C**

5. Derive an expression for the gravitational potential at a point outside, on the surface and inside a solid sphere. (14)
6. State and prove the Kepler's laws of planetary motion using the concept of reduced mass. (14)

**Section D**

7. Define Coriolis force. Discuss its effect on a particle moving on the surface of earth. Calculate the horizontal and vertical component of Coriolis force. (14)
8. Explain the term non inertial frames of reference and ficticious force. Calculate the total force and ficticious force acting of the body in a non inertial frame. (14)

**Exam Code: 508601** **Paper Code: 1205**

**Programme: Master of Science (Physics) (FYIP) Semester-I**

**Course Title: Thermal Physics**

**Course Code: FPHL-1394**

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

**Note:** Candidates are required to attempt five questions selecting one question from each section. The fifth question may be attempted from any section. Each question carries 14 marks. Students can use Non-Scientific calculator or logarithmic tables.

## Section-A

1. (a) The P-V diagram for a cyclic process in a triangle ABC drawn in order. The co-ordinates A,B,C are (4,1); (2,4) and (2,1). The co-ordinates are in order P-V. Pressure is in $Nm^{-2}$ and volume is in litre. Calculate the work done during the process from A to B; B to C and C to A. Also calculate the work done in complete cycle.

(b) What is the basis of thermodynamics scale of temperature? Show that for a given sink temperature, the mechanical energy required to extract a given amount of heat from a cold body increases with decreasing temperature of the body.

2. Explain the Carnot cycle using a PV diagram and derive the efficiency of a Carnot heat engine that uses one mole of an ideal gas as its working substance. What are the reasons that make it impossible to implement a Carnot engine in practice?

## Section B

3. (a) Derive the following Maxwell's thermodynamical relations

i) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

ii) $\left(\frac{\partial P}{\partial S}\right)_V = -\left(\frac{\partial T}{\partial V}\right)_S$

(b) Using Maxwell's thermodynamical relations, prove that $C_p$-$C_v$ = R for a perfect gas and show that the vander Waal gas becomes identical with a perfect gas under certain conditions.

4. (a) Discuss mathematically the cooling is produced when a thin film is stretched adiabatically.

(b) Prove that for any substance

$$TdS = C_p dT - T\left(\frac{\partial V}{\partial T}\right)_p dP$$

## Section C

5. Give an account of Joule-Thomson experiment. Show that the change in temperature in a Joule-Thomson expansion is given by

$$dT = \frac{V}{C_p}(T\alpha - 1)dP$$

Why does an ideal gas show neither a heating nor cooling effect in Joule-Thomson expansion. Analyse thermodynamically Joule Thomson effect for Vander Waal gasses.

6. Derive the expression for cooling produced by adiabatic demagnetisation of paramagnetic salt. Give theoretical discussion.

## Section D

7 (a) Explain how the concept of Doppler broadening is useful in determining velocities of stars and galaxies relative to earth.

(b) State and prove the law of equipartition of energy. Describe it's any one application.

8. Derive the expression of Maxwell-Boltzmann law of molecular speeds and hence derive the expressions for the most probable speed, average speed, and root mean square speed. Explain it by using the graphical representation.

Exam Code: 508601 Paper Code: 1206

**Master of Science (Physics) (FYIP) Semester-I**

**Course Title: Mathematics-I**

**Course Code: FPHL-1335**

**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**

1. (a) Examine the continuity of the function $f(x) = \begin{cases} 2x+1, & x \leq 2 \\ 3x-1, & x > 2 \end{cases}$ at x=2

(b) If $y = e^{hx} \sin kx$, check whether or not $y'' - 2hy' + (h^2 + k^2)y = 0$.

2. (a) State and prove Euler's Theorem.

(b) If $u = \frac{1}{\sqrt{x^2+y^2+z^2}}$ ; $x^2 + y^2 + z^2 \neq 0$. Check whether $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = 0$ or not.

**Section-B**

3. (a) State and Prove Rolle's theorem.

(b) Prove whether or not the asymptotes of the curve $x^4 - 5x^2y^2 + 4y^4 + x^2 - y^2 + x + y + 1 = 0$ cut the curve in atmost eight points which lie on rectangular hyperbola.

4 (a) Apply Taylor's theorem with Lagrange's form of remainder to the function

$f(x) = \sin x \text{ in } \left[\frac{\pi}{2}, x\right]$.

4. Examine $y = 2 - x^2$ for concavity upwards, concavity downwards and points of inflexion.

**Section-C**

5. (a) Evaluate $\int (2x - 3\cos x + e^x)\, dx$

(b) Verify $\int_3^4 \int_1^2 (x^2 + y^2) dy\, dx = \int_1^2 \int_3^4 (x^2 + y^2) dx\, dy$

6. (a) Evaluate $\int \frac{x}{(x+1)(x+2)}\, dx$

(b) Obtain a reduction formula for $I_n = \int \tan^n x\, dx$. Hence evaluate $I_4$

## Section-D

7. (a) If $A = \begin{bmatrix} 2+i & 3 & -1+3i \\ -5 & i & 4-2i \end{bmatrix}$, check whether $AA^*$ is a Hermitian matrix, where $A^*$ is the conjugate transpose of A.

(b) Prove or disprove: Every square matrix satisfies its characteristic equations.

8. (a) Reduce the matrix $A = \begin{bmatrix} -1 & 2 & -2 \\ 1 & 2 & 1 \\ -1 & -1 & 0 \end{bmatrix}$ to the diagonal form

(b) Find the value of k so that the equations $x - 2y + z = 0, 3x - y + 2z = 0, y + kz = 0$ have

(i) Unique solution

(ii) Infinitely many solutions. Also find solutions of these values of k.

**Exam Code: 508601** **Paper Code: 1207**

**Programme: Masters of Science (FYIP) Physics**

**Semester – I**

**Course Title: Organic Chemistry**

**Course Code: FPHL- 1086**

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

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

**Section – A**

1(a) HCOOH is stronger but $ClCH_2COOH$ acid is weaker acid than $CH_3COOH$. Explain briefly the concept of inductive effect with reason. (7)

(b) What do you understand by hypercongugation? Why is it called "No Bond Resonance"? Give its significance. (7)

2(a) What are carbocation? Discuss structure, stability and generation of carbocation reactive intermediate. (7)

(b) Explain why vinyl halides and aryl halides are less reactive than alkyl halides on the basis of resonance effect. Draw resonance structures in support of your answer. (7)

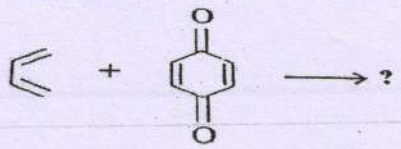
**Section – B**

3(a) What do you understand by 1,2 elimination reaction. Discuss in briefly the E2 mechanism and orientation of dehydrohalogenation reaction by taking suitable example. (7)

(b) What is peroxide effect? Explain the mechanism for addition of HBr to propene in the presence of benzoyl peroxide. Why is this effect not shown by HCl or HI? (7)

4(a) Discuss the mechanism of acidic dehydration of alcohols to ethyl alcohol. Discuss order of reactivity of 1°,2° ,3° alcohols and orientation of dehydration on basis of Saytzeff rule. (7)

(b) Write a note on acidity of alkyne and identify the reaction and write mechanism of following organic transformation. (7)



## Section – C

5(a) Explain why sterically hindered epoxides in acid conditions g' $SN_1$ substitution whereas in basic conditions it follow $SN_2$ mechanism. Explain the mechanism of both by suitable example. (7)

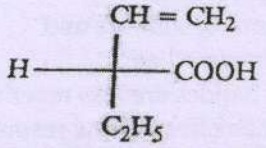
(b) Discuss the mechanism of the Witting reaction and its role in organic chemistry. (7)

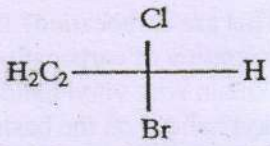
6(a) Discuss SN2 mechanism of nucleophilic substitution reaction with detailed discussion on rearrangement, stereochemistry and solvent effect. (7)

(b) Write a note on Auto oxidation and Zielsel method for alkoxy group determination. (7)

## Section- D

7(a) Explain the concept of Meso isomers and Racemic mixture and their importance in sterochemistry. (7)

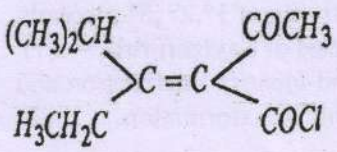


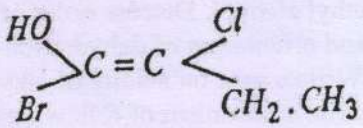




(b) Discuss the Cahn-Ingold-Prelog rules for assigning R and S configurations. Assign R and S configuration to be following Fischer Projection formulae. (7)

8(a) What do you understand by conformational isomerism. Explain the conformations of ethane with help of energy profile diagram. (7)

(b) What are geometrical isomers. Write conditions and rules of geometrical isomerism to assign the E/Z configuration to the following: (7)



Exam Code : 225501 Paper code : 1208

**Master of Science (Physics)**
**Semester-I**
**Course Title: Analog and Digital Electronics**
**Course code: MPHL-1391**

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

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

Section A

1. (a) Write in detail construction and working of U.J.T and its application. (7)
(b)Explain the working of S.C.R and discuss its application. (7)

2 (a) Explain the following

(i) N.M.O.S static cell (ii) R.O.M (iii) EPROM (iv) EEPROM (7)

(b) Write in detail working of MOSFET. (7)

Section B

3 (a) What are Operational Amplifiers and its types? Discuss its input and output impedance. (7)

(b) Write a note on Schmitt trigger and Logarithmic amplifiers (7)

4 Explain the following

(a) Electronic Analog computational circuit (b) Integrator (c) Differentiator

(d) Summer in context of Operational Amplifiers (14)

Section C

5 (i) Convert the following

(a) $(25.15625)_{10}$ to binary (b) $(27)_{10}$ to binary (c) $(11011101100)_2$ to hexadecimal

(d) Prove the following (i) $A+\bar{A}B = A+B$ (ii) $(A+B).(A+C)= A+BC$ (4X2=8)

(ii) Explain the working of

(a) Parity generators and encoders

(b) Adder Subtractor circuits (2X3=6)

6 (i) Simlify the following functions using K maps

(a) f (ABC) = m (1,3,4,5,7) (b) f(WXY) = m(3,5,6,7)

(ii) Simplify the following expressions using Boolean algebra (2X3.5=7)

(a) $(\bar{A}+B+\bar{C}).(\bar{A}+B+D+E).(C+D)$

(b) $A[B+C(\overline{AB + AC})]$ (2X3.5=7)

Section D

7. Explain the concept of

(a) RS flip flop (b) Binary Ladder (c) Analog to Digital Converter (14)

8. Write a note on the following

(a) Registers (b) Up-Down Counters (c) Digital to Analog Converter (14)

**Exam Code:225501** **Paper Code: 1209**

**Programme: Master of Science (Physics) Semester-I**
**Course Title- Mathematical Physics**

**Course Code: MPHL-1392**

**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. Find the expression of divergence for a system of curvilinear coordinates 9
   b. Find the components of velocity of a particle in cylindrical polar coordinate system. 5
2. a. Consider the one-dimensional wave equation $\frac{\partial^2 y}{\partial x^2} - c^2 \frac{\partial^2 y}{\partial t^2} = 0$ where C is a constant. Use the Fourier transform method to find the solution u(x,t) with initial conditions u(x, 0)=f(x) 9
   b. Find the Fourier series to represent sin x for $x \in (-\pi, \pi)$. 5

**Section-B**

3. a. Compute the contour integral $\oint_C \frac{(z^2+1)}{(z^4+1)}\, dz$ using Cauchy's residue theorem, where C is the unit circle |z| = 1, oriented counterclockwise. 4
   b. Compute the integral of the function $f(z) = \frac{\cos z}{z^2-1}$ around the contour C, where C is the unit circle. 4
   c. Determine the Laurent series expansion of $f(z) = \frac{\sin z}{z}$. 6
4. a. State and prove Laurent series expansion of an analytic function. 8
   b. Expand the following functions using taylor's series Expansion 6

$$f(x) = \cos 4x \ about\ x = 0$$
$$f(x) = x^6 e^{2x} \ about\ x = 0$$

**Section-C**

5. a. Compute gamma function of 7/2. 3
   b. Show that the functions f(t)=sin t and g(t)=$e^{2t}$ are linearly independent. 3
   c. Use the recurrence relation $J_{n+1}(x) = \frac{2n}{x} J_n(x) - J_{n-1}(x)$ to compute $J_4(x)$ 4
   d. Show that the Legendre Polynomial $P_n(x)$ satisfies the following recurrence relation
   $$nP_n(x) = (2n-1)xP_{n-1}(x) - (n-1)P_{n-2}(x)$$ 4
6. a. Find the solutions to Bessel's Differential equation using Frobenius method 10
   b. Derive the relationship between beta and gamma function 4

**Section-D**

7. a. Let G be a group, and H be a subgroup of G. Prove that the identity element of G is also the identity element of H. 3
   b. Prove that every cyclic group is abelian. 3
   c. Let G be the set of all matrices of the form $\begin{bmatrix} a & b \\ 0 & c \end{bmatrix}$ where a, b, c are real numbers such that $ac \neq 0$. Prove that G forms a group. 8
8. a. Prove that nonzero rational numbers form a group under multiplication and check if the group is abelian or not. 4
   b. Let S be the set of even integers. Show that S is a group under addition of integers. 3
   c. Define U(n) and SU (2) groups. Derive the matrix formation of SU (2) group 7

Exam Code: 225501 Paper Code: 1210

**Master of Science (Physics) Semester – I**
**Course code: MPHL-1393**
**Classical Mechanics**

**Time: 3 Hours** **Marks: 70**

**Note: Attempt any five questions from following sections selecting at least one from each section. Each question carries equal marks (14). Students can use non-scientific calculator if necessary.**

## Section A

1. (a)What do you mean by constrained motion? Discuss main types of constraints. (5)
   (b) Prove the laws of conservation of linear momentum, angular momentum and energy for a system of interacting particles. (9)

2. (a) Derive Lagrange's equations of motion for a conservative system. (9)
   (b)The Lagrangian for a particle of mass m, at a position $\vec{r}$ moving with a velocity $\vec{v}$ is given by
   $$L = \frac{1}{2}mv^2 + c\,\vec{r}.\vec{v} - V(r)$$
   Where V(r) is a potential and c is a constant. If $\overrightarrow{p_c}$ is the canonical momentum, then find its Hamiltonian. (5)

## Section B

3. (a) What is differential scattering cross-section? Discuss the problem of scattering of charged particles by a coulomb field and obtain Rutherford's formula for the differential cross-section. (14)

4. (a) Derive the conditions for the stability and closure of an orbit when a particle is moving under central force field. (7)
   (b)State and prove Kepler's first law of planetary motion. (7)

## Section C

5. (a) Derive transformation equations for the generating functions of types $F_1(q, Q, t)$, $F_2(q, P, t)$. (9)
   (b) A canonical transformation (q,p)→(Q,P) is made through the generating function F(q, P) = $q^2P$ on the Hamiltonian $H(q, P) = \frac{p^2}{2\alpha q^2} + \frac{\beta}{4}q^4$ where α and β are constants. Find the equations of motion for (Q,P). (5)

6. (a) State and prove the principle of least action. (9)
(b) Prove that under canonical transformation (q,p)→(Q,P),

$$[F, G]_{q,p} = [F, G]_{Q,P}$$ (5)

## Section D

7. Discuss Euler's angles. Discuss rotational transformation using Euler's angles. (14)

8. (a) Calculate the inertia tensor for the system of four point masses 1gm, 2gm, 3gm and 4 gm, located at the points (1,0,0), (1,1,0), (1,1,1) and (1,1,-1) cm. (5)

(b)Explain the general theory of small oscillations and obtain the Eigen value equation. (9)

Exam Code: 225501

Paper Code:1211

**Programme: Master of Science (Physics)**
**Semester: I**
**Course Title: Computational Techniques**
**Course Code: MPHL-1394**

**Time Allowed: 3 Hours**

**Max Marks: 70**

**Note: Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section. Each question carries 14 marks. Students can use Non-programmable scientific calculators or trigonometric/logarithmic tables.**

## Section A

1. (a) Write a function file to find the factorial of a number? (3)
   (b) Plot $y = e^{-0.4x} \sin x$, $0 \leq x \leq 4\pi$, taking 10, 50, and 100 points in the interval. (3)
   (c) How you can reshape matrices, transpose them and append and delete a row or column in a matrix? (8)
2. Discuss all the loops, branches and control flow statements in MATLAB with the help of appropiate examples? (14)

## Section B

3. (a) Derive Lagrange's interpolation formula? When it is preffered? (7)

   (b) Estimate from the following table the no. of students who got the marks between 40 and 45? (7)

| Marks : | 30 – 40 | 40 – 50 | 50 – 60 | 60 – 70 | 70 – 80 |
|---|---|---|---|---|---|
| No. of Students : | 31 | 42 | 51 | 35 | 31 |

4. (a) Derive Newton's interpolation formula which is preffered to use when we have data with unequal intervals? (7)

   (b) Compute $f(8)$ for the following data. (7)

| $x$: | 4 | 5 | 7 | 10 | 11 | 13 |
|---|---|---|---|---|---|---|
| $f(x)$: | 48 | 100 | 294 | 900 | 1210 | 2028 |

## Section C

5. (a) The velocity of a train in km/min with initial velocity 1 km/min is given in fixed intervals of time t in minutes:

| t | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 |

Find the displacement of the train in 1 min by Simpson 3/8 rule. (7)

(b) Drive Simpson's 1/3 rule to solve numerical integration? Why this method is preferred over trapezoidal rule. Explain graphically? (7)

6. Using Runge-Kutta fourth order method, find approximate value of y correct up to three decimal places in the interval [0,0.4] using step size h=0.1 if (14)

$$10\frac{dy}{dx} = x^2 + y^2$$

given that $y = 1$ when $x = 0$

## Section D

7. Discuss the Regula Falsi method graphically and find the root of $x^3 - 5x + 3 = 0$ correct to three decimal positions by using this method. (14)

8. (a) Explain the least square method for curve fitting and find the expression for regression coefficients for straight line fit of x on y and y on x. (7)

(b) Fit the following data by exponential function of the form $y = Ae^{Bx}$

| | | | | |
|---|---|---|---|---|
| *x:* | *600* | *500* | *400* | *350* |
| *y:* | *2* | *10* | *26* | *61* |

(7)