COURSE FILE

AY 2023 - 2024

MSc(Physics)

Semester-I

Paper- I

Mathematical Physics

Principal
Vaagdevi Degree & P.G. College
Kishanpura, Hanamkonda

VAAGDEVI DEGREE & PG COLLEGE
DEPARTMENT OF PHYSICS
COURSE FILE-I SEM-MATHEMATICAL PHYSICS 2023-2024

Name of the faculty	M. GOPI KRISHNA
Designation	ASSISTANT PROFESSOR
Email	pintoomora@gmail.com
Course code	101
Course Title	Mathematical Physics
ACADEMIC YEAR / SEMESTER	2023-24 / I-Sem
NUMBER OF INSTRUCTIONAL HOURS	68

1. INTRODUCTION TO THE COURSE:

Mathematical physics refers to the development of mathematical methods for application to problems in physics. The Journal of Mathematical Physics defines the field as "the application of mathematics to problems in physics and the development of mathematical methods suitable for such applications and for the formulation of physical theories". An alternative definition would also include those mathematics that are inspired by physics.

Vision

To be a center of excellence in value based holistic quality education carving research, innovation and entrepreneurial attitude that transforms students into globally competent society sensitized graduates.

Mission

- To create a student centric institute support with innovative student pedagogy
- To maximize the utilization of the state-of-the-art infrastructure for the overall development of individuals.
- To encourage independent thinking and application-oriented collaborative research in the areas of contemporary interest to contribute to the development of the region and the nation.

- To provide effective teaching& learning environment for training graduates with values, entrepreneurial attitude and globally employable skills.
- To encourage participation in games & sports, co-curricular and extra-curricular activities resulting in overall personality development.

Program Outcomes (P.O.)

PO1 To create, apply, and disseminate knowledge of physics in theoretical and experimental domains under different specializations.

PO2 To develop the ability to identify, formulate, analyze and solve problems in theoretical and experimental domains of physics at both curricular and research levels through critical thinking.

PO3 To enable students to apply ICT-based skills and make them scientific software literate to use in academics.

PO4 To encourage research culture, provide research ambience and develop related technical proficiency.

PO5 To develop an attitude to pursue further research and find placement avenues.

PO6 To inculcate academic and social ethical values among the students

Program Specific Outcomes (PSO)

PSO1

Students can apply the knowledge of core concepts of physics in semester exams, in the N.E.T., S.E.T. and GATE, national level exams, as well as in the research level projects work which is suitable to communicate/present further in workshops and conferences

PSO2

Through assignments, NET-SET coaching workshops and research-based project work in both theoretical and experimental domains, students can reveal analytical skills and critical thinking

PSO3

In day to day's access to study material through presentations, students are capable enough to make use of PowerPoint presentations, Moodle (L.M.S.), and Web-based academic links and can also get hands-on experience of using proprietary software like MATLAB, and Mathematica under experiential learning.

PSO4

Through the research culture of the department and skills acquired therein, students are capable of
sustaining subsequent academic progression inside the country and overseas as well

PSO5

Regular practice of Self-declaration of the authenticity, uniqueness of project work, plagiarism check

Course Outcomes		
Semester-I		
Course code	**Course title**	**Course outcomes**
101	Mathematical Physics	1. Students can understand the different ways of solving first and s econd-order differential equations. 2. Students can understand and solve the problems based on special functions like Hermite, Bessel, Laguerre and Legendre functions. 3. Students can understand fundamentals of Hypergeometric functions and applications 4. Students can understand fundamentals and applications of the Fourier series, Fourier and Laplace transform, their inverse transforms etc.

VAAGDEVI DEGREE AND PG COLLEGE

Kishanpura, Hanamkonda

MSc(Physics) Sem-I Time table (2023-24)

	9:00 TO 9:50	9:50 TO 10:40	10:40 TO 11:30	11:30 TO 12:40	12:40 TO 1:30	1:30 TO 2:20	2:20 TO 3:10
MON	MPS (MGK)	CMS (KK)	SSP (GM)	LUNCH	MON, TUE, WED GP LAB (Dr. Baishali Chakraborthy, G. Madhukar) THU, FRI, SAT ELE LAB(S. Anusha, B. Bhavya, N. Niharika)		
TUE	MPS (MGK)	CMS (KK)	SSP (GM)				
WED	ELE (Dr.MNM)	MPS (MGK)	CMS (KK)				
THU	ELE (Dr.MNM)	MPS (MGK)	CMS (KK)				
FRI	SSP (GM)	ELE (Dr.MNM)	SEMINAR H.NAVYA				
SAT	SSP (GM)	ELE (Dr.MNM)	SEMINAR H.NAVYA				

Subject Code	Subject	Name of the Faculty	Signature
101	MATHEMATICAL PHYSICS	M. GOPI KRISHNA	

M.Sc. (Physics) I - Semester Syllabus under CBCS pattern
(For 2021-22 academic year onwards)

1.1: MATHEMATICAL PHYSICS

UNIT I: LEGENDRE AND BESSEL DIFFERENTIAL EQUATIONS (12 Hrs)

Legendre differential equation and Legendre functions, Generating function of Legendre polynomials, Rodrigues formula for Legendre polynomials, orthogonal property of Legendre polynomials, recurrence formula. Power series solution equation –Bessel functions of First and Second kind –Generating function – Orthogonality – Neumann functions – Hankel functions –modified Bessel functions – Spherical Bessel functions - Recurrence relations.

UNIT II: LAGUERRE AND HERMITE DIFFERENTIAL EQUATIONS (12 Hrs)

Laguerre differential equations and polynomials, Generating function for Laguerre polynomials, recurrence relation, Rodrigues formula for Laguerre polynomials, orthogonality property. Hermite differential equation and polynomials, Generating function for Hermite polynomials. Integral formula for Hermite polynomial, Recurrence formula, Rodrigues formula, orthogonality of Hermite polynomials.

UNIT III: VARIABLE FUNCTIONS (12Hrs)

Hypergeometric equation, Hypergeometric functions, Differentiation of hyper geometric function and its integral representation, linear transformations, representation of various functions in terms of hyper geometric functions, confluent hyper geometric functions, representation of various functions in terms of hyper geometric functions. Beta and gamma functions: symmetry property, evaluation and transformation of Beta function, evaluation of gamma function, transformation of gamma function, relation between beta and gamma functions. Evaluation of integrals using Beta & gamma functions.

UNIT IV: FOURIER AND LAPLACE TRANSFORMATION (12Hrs)

Integral transforms, Fourier transforms and their properties, Convolution theorem for Fourier transforms, Parseval's theorem, Simple applications of Fourier transforms .Evaluation of integrals, solution of boundary value problems. Laplace transforms and their properties, Laplace transform of derivatives and integrals, Laplace transform of periodic functions, initial and final value theorem, Laplace transform of some special functions, inverse Laplace transforms, Convolution theorem.

Recommended Books:

1. Mathematical methods for Physicists – **Geroge B. Arfken & H.J.Weber (Academic Press)**
2. Mathematical methods in Physics and Engineering – **L. A. Pipes**
3. Mathematical Physics –**Satyaprakash (S. Chand)**
4. Mathematical Physics – **B. D. Gupta (Vikas Publishing House Pvt. Ltd).**

TEACHING PLAN:

Sl No	Unit / Topic	Teaching Planned on Date	No of Periods Planned	Course Outcomes	Teaching aids used	Books Referred
1	. **Unit I** : Legendre differential equation and Legendre functions, Generating function of Legendre polynomials, Rodrigues formula for Legendre polynomials, orthogonal property of legndre polynomials, recurrence formula. Bessels function of first and second kind, Generating function, Orthogonality, Numman function, Henkel functions, Modified bessels fuctions, Spherical functions, Recurrance formula	1/11/2023 TO 28/11/2023	16	CO1, CO2	Laptop, Smart phone	• Mathematical Physics by **Satyaprakash** • Mathematical Physics by **B.D. Gupta**
2	**Unit II :** Laguerre differential equations and polynomials, Generating function for Laguerre polynomials, recurrence relation, Rodrigues formula for Laguerre polynomials, Orthogonality property. Hermite differential equation and polynomials, Generating function for Hermite polynomials, Integral formula for Hermite polynomial, recurrence formula, Rodrigues formula, orthogonality of Hermite polynomials.	29/11/2023 TO 16/12/2023	15	CO2	BLACK BOARD, CHALK AND DUSTER , ICT CLASS ROOM	• Mathematical Physics by **Satyaprakash** • Mathematical Physics by **B.D. Gupta**
3	**Unit III :** Hypergeometric equation, Hypergeomatric function: Differentiation of hyper, geometric function and its integral representation, linear transformations, representation of various functions in terms of hyper geometric functions, confluent hyper geometric functions, representation of various functions in terms of hyper geometric functions. Beta and gamma functions: symmetry property, evaluation and transformation of Beta function, evaluation of gamma function, transformation of gamma function, relation between beta and gamma functions. Evaluation of integrals using Beta & gamma functions.	18/12/2023 TO 25/01/2024	23	CO3	BLACK BOARD, CHALK AND DUSTER	• Mathematical Physics by **Satyaprakash** • Mathematical Physics by **B.D. Gupta**
4	**Unit IV** : Integral transforms, fourier transforms and their properties, convolution theorem for Fourier transforms, Parseval's theorem, simple applications of Fourier transforms. Evaluation of integrals, solution of boundary value problems. Laplace transforms and their properties, Laplace transform of derivatives and integrals. Laplace transform of periodic functions, initial and final value theorem, Laplace transform of some special functions, inverse Laplace transforms, Convolution theorem.	29/01/2024 TO 22/02/2024	14	CO4	BLACK BOARD, CHALK AND DUSTER	• Mathematical Physics by **Satyaprakash** • Mathematical Physics by **B.D. Gupta**

List of Recommended Text Books

SNO	Name of the Book	Author
1	Mathematical methods for Physicists	**Geroge B.Arfken & H.J. Weber**
2	Mathematical Physics	**Satyaprakash**

List of Reference Text Books

SNO	Name of the Book	Author
1	Mathematical Physics	**Satyaprakash**
2	Mathematical Physics	**B.D. Gupta**

List of URL's to be Referred

SNO	Name of the URL
01	https://www.youtube.com/watch?v=clymUA0hu4s
02	https://www.youtube.com/watch?v=EDVJotmT584

METHODOLOGY FOR CONTINUOUS INTERNAL EVALUATION & EXTERNAL ASSESSMENT:

SNO	NAME OF THE EXAM	MAX MARKS
01	Unit test	10
02	Internal examinations	20

RECORD OF TUTORIAL CLASSES CONDUCTED

SNO	DATE	NAME OF FACULTY	TUTORIAL TOPIC
1	1/11/2023	M. GOPI KRISHNA	Legendre differential equation
2	14-11-2023	M. GOPI KRISHNA	Orthogonality
3	20-11-2023	M. GOPI KRISHNA	Bessels function
4	23-11-2023	M. GOPI KRISHNA	Generating function, Orthogonality
5	1/12/2023	M. GOPI KRISHNA	Lauagurre polynomials
6	19-12-2023	M. GOPI KRISHNA	Hypergeometric function
7	20-12-2023	M. GOPI KRISHNA	Gauss hypergometric function
8	5/1/2024	M. GOPI KRISHNA	Beta and gamma function, its properties
9	24-1-2024	M. GOPI KRISHNA	Evaluation of integrals
10	29-1-2024	M. GOPI KRISHNA	Fourier transforms
11	6/2/2024	M. GOPI KRISHNA	Laplace transforms
12	13-2-2024	M. GOPI KRISHNA	Inverse laplace transforms

RECORD OF STUDENT SEMINARS

S.No.	H.T. No.	NAME	TOPIC
1	24117-S-0401	K. BHAVANI	Legendre differential equation and Legendre functions
2	24117-S-0402	J. PRAVALIKA	Laguerre differential equations and polynomials
3	24117-S-0405	T. RANJITHA	Hypergeometric equation
4	24117-S-0407	D. MOUNIKA	Hermite polynomials

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M.Sc (PHYSICS), SEMESTER - I, PAPER – I

MATHEMATICAL PHYSICS

INTERNAL – I

Answer all questions.

Each question carries 2 marks.

1. Show that $P_n(1) = 1$
2. Prove that $P_n(-x) = (-1)^n P_n(x)$
3. Using Rodrigues formula $\int_{-1}^{1} x^2 P_5(x)dx = 0$
4. Using Rodrigues formula $\int_{-1}^{1} P_0(x)dx = 2$
5. Using Rodrigues formula $\int_{-1}^{1} P_n(x)dx = 0$
6. $H_n'(x) = 2xH_n(x) - Hn+1(x)$
7. Prove $2xH_n(x) = H_{n+1}(x) + 2nH_{n-1}(x)$
8. Show that $H_n(-x) = (-1)^n H_n(x)$
9. Show that $H_{2n}(0) = (-1)^n \frac{2n!}{n!}$
10. $\frac{1}{e} cosh2x = \sum_{n=0}^{\infty} \frac{H_n(x)}{2n!}$

M.Sc (PHYSICS), SEMESTER - I, PAPER – I

MATHEMATICAL PHYSICS

INTERNAL – II

Answer all questions.

Each question carries 2 marks.

1. Show that $e^x = {}_1F_1(\alpha, \alpha; x)$
2. Evaluate the value of $\int_0^{\infty} \frac{x^8(1-x^6)}{(1+x)^{24}} dx$
3. Define beta function
4. Define gamma function.
5. Show that $\Gamma(n) = (n-1)!$
6. Define Fourier transform.
7. Define Laplace transform
8. Find the Laplace transform of sinhat
9. Find the Laplace transform of sinat
10. Find the Laplace transform of cosat

STUDENT PROGESSION AND MARKS STATEMENT

S.NO.	H.T.NO	STUDENT NAME	INT-1	INT - 2
1	24117-S-0401	K. BHAVANI	20	18
2	24117-S-0402	J. PRAVALIKA	18	19
3	24117-S-0403	T. RANJITHA	19	18
4	24117-S-0404	D. MOUNIKA	20	18

Teaching Notes

Unit no	Topics	Synopsis	Hours allotted	Hours taught	Extra hours taken	Reason
UNIT-I	**Legendre and Besells differential equation and polynomials**	Generating function, ,Rodrigues formula , orthogonal property of Legendre and Bessels polynomials	16	16		
UNIT-II	**Laguerre differential equations and polynomials, Hermite polynomials**	Generating function, ,Rodrigues formula , orthogonal property Laguerre polynomials, Hermite polynomials	15	15		
UNIT-III	**Hypergeometric equation and function, Confluent hyper geometric functions, Beta and gamma functions**	Differentiation and integration, linear transformations, representation of various functions of hyper geometric function, Confluent hyper geometric functions, representation of various functions in terms of hyper geometric functions. Beta and gamma functions and their properties	23	23		
Unit IV	**Fourier transforms and Laplace transforms**	Fourier transforms and their properties, convolution theorem for Fourier transforms, Parseval's theorem, Laplace transforms and their properties, inverse Laplace transforms, Convolution theorem.	14	14		

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